THE

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J. A. BERLY'S

UNIVERSAL ELECTRICAL DIRECTORY

For 1893

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THE NEW WESTINGHOUSE LAMP AND ELECTRIC LIGHTING IN AMERICA.

THE *Electrical World* for January 7th contains some further particulars respecting the new form of lamp, which is still on the eve of appearing, and of lamp matters generally in the United States. The Westinghouse Company has made another public announcement, a portion of which reads as follows:—

"By reason of manufacture of the lamps by special machinery and improved methods, by the use of nitrogen for preserving the carbons, and by means of pumping and charging apparatus recently perfected, we have been able to so reduce the cost of manufacture as to fix our prices for 8, 10 and 16 C.P. lamps at 30 cents. each, subject to a discount of 10 per cent. to our central station customers, and to others from 2½ per cent. upward, according to quantity, with an allowance of 10 cents. for every burned-out lamp returned unbroken to any one of our factories, making the net cost of renewals for the 8, 10 and 16 C.P. lamps 17 cents. to our central station customers. For 20 and 25 C.P. lamps the prices will be 35 cents. each, subject to the same discount and allowance for burned-out lamps.

"By long and careful tests, and by the use of a large number of these lamps in our works, we have demonstrated that the new lamp will have greater advantages for users than the Edison lamp or any of those heretofore upon the market.

"The importance of the improvements in manufacture by which we have been enabled to offer these lamps at so low a price will be appreciated by all users who are aware of the constant deterioration in the carbon burners, and of the fact that the real commercial efficiency of a lamp is its average efficiency. With a constant amount of electric current the ordinary 16 C.P. lamps rapidly fall below 10 C.P. from the deterioration of the carbon, when they must be renewed; and it results from this that the users, with cheaper lamps, will get from 15 to 20 per cent. more light from a given expenditure of electricity by a more frequent renewal of lamps than is now customary. Thus the low cost of the lamps may be made to add to the revenue of a lighting station in one of two ways, viz., either by giving a greater lighting capacity at the present cost of lamp renewals, or by actual saving in the cost of lamps with renewals made at the present period of renewal."

The references in this statement to the technical points of manufacture are put together in a very oracular manner. The somewhat startling mention of using nitrogen for preserving the carbons, for example, is exceedingly vague. We cannot think as Dr. Böhm (who has a sensible article on the subject in the same issue) seems to imagine is the case, that it is seriously proposed to fill the bulbs with nitrogen gas. No one with the least experience in the lamp line, we think, would dream of doing such a thing nowadays. But there is nothing outrageously absurd in the proceeding of substituting a residual atmosphere of this gas—if it has been found

to be beneficial—for the gases given off by the filament during exhaustion. The only point to be advanced against such a plan is the cost and difficulty of first removing the occluded gases from the filaments and then introducing some nitrogen, to be again removed, of course, as completely as possible. There is no hint in the announcement of the employment of such a process, but unless the allusion to nitrogen is a mere blind devised to cause yet another difference to the Edison claims, we can conceive of no other rational explanation for its use.

The particulars as to the value of new, returned, and repaired lamps will be read with interest. In commenting on the modified form of lamp not long since in this Journal, we gave it as our opinion that new lamps could not be turned out at so low a cost as those of usual construction, and the allowance of 5d. for a returned lamp unbroken certainly confirms this opinion. At outside prices by the sealing-in method, the cost of bulb, platinum and labour, does not reach 2½d.; and the deduction to be drawn is, that if the company were at liberty to employ the sealing-in method, it could sell lamps for about 1s. each. This is not far from what is rapidly becoming the current price on the European Continent, viz., 10d. each. The cost of renewing a worn-out Westinghouse lamp is, therefore, only three halfpence below this price, exclusive of the cost of transport to the works for renewal. In connection with renewing old lamps, it is the company's intention to start "renewal stations" in various large cities, so as to reduce the cost to the consumer of returning worn out lamps to the central factory.

Provided the lamps are a success in a general sense, the remarks in the above quotation, anent the policy of running them at a higher efficiency than is economical with those which cannot be renewed, are true enough in strict principle. The consumer would save 2d. or 3d. per lamp after, say, a run of 400 or 500 hours, and, in addition, would obtain either more average light for a given expenditure of current, or spend less on current, and get the same amount of light. But average light and uniform light are not synonymous terms, and a more uniform light (obtained by forcing the lamps less) may perhaps be more valued by some than a rapidly falling light, although its average intensity be greater.

It is stated to be the intention of the Westinghouse Company to manufacture these separable lamps at the rate of 15,000 to 20,000 per day, exclusive or renewals. This is no insignificant rate, even when compared with the colossal output of the English Edison-Swan monopolies.

With regard to the attitude of the various Edison illuminating companies that have been started in the States towards the General Electric Company, which now controls the Edison patents, it is by no means of a friendly nature. And for this reason: These illuminating companies, who own some three-fourths of the whole incandescent lighting business in America, bought, in early days, the exclusive right to sell and use Edison lamps in their respective territories, and in return for the privilege, assigned to the Edison Company a portion of their respective stocks. Infringing companies next spring up, and sell electric lighting apparatus within their domains, without let or hindrance, and at a cheaper rate than the original illuminating companies had to pay the parent company for their supplies. It thus happened that the Edison licensees have not made the amount of profit they had a right to make. Hence the unfriendly spirit towards the Edison Electric Company; and the animosity is greater still against the General Electric Company, since many of their bitterest rivals (which have been from time to time absorbed by the Thomson-Houston Company) are now affiliated with the Edison combination. By way of retaliation they have now the power to say, "we will not allow *you* to sell any lamps in *our* territory; and we ourselves will not sell lamps to any of our customers except at a price *we* may fix upon. And further, we refuse to sell lamps at all to our rivals—the Thomson-Houston, Brush, Fort Wayne, Jenny, &c." Nor is this all; for prior to the amalgamation of Edison with Thomson-Houston, the latter had guaranteed *its* licensees against liability for possible infringement of the Edison patent; so that should these rival lighting companies now be unable to obtain lamps in consequence of action on the part of the Edison licensees, they have the right to sue the General Electric Company for damages. Thus all these circumstances combine to place the General Electric Company in a very awkward position, and it seems questionable whether it will derive much benefit from the recent victory it has gained in the law courts. It is not surprising to learn that the embarrassed situation is having a very detrimental influence on the trade just at present, but hopes are entertained that before very long important developments in the direction of relieving the situation will be arrived at.

TECHNICAL EDUCATION.

THE report to the Special Committee on Technical Education, by Mr. H. Llewellyn Smith, M.A., B.Sc., secretary to the committee, has now been published. It contains the result of an enquiry into the needs of London with regard to Technical Education, the existing provision for such education, and the best means to be taken by the London County Council for improving that provision.

From the nature of the case, the breadth and scope of the report must be very great, dealing, as it does, with the direct interests of the whole population of the metropolis. Nearly every section of it opens with a few paragraphs on the general principles involved, and passes to the consideration of existing states of fact, ending with detailed practical proposals. Taking for granted the desirability of Technical Education, Mr. Llewellyn Smith boldly fronts the question, pointing out the directions from which aid may be expected, and hinting how such aid could be most fitly applied.

The meaning of "Technical Education" is taken to imply instruction in the principles of science and art applicable to industries, and in the application of special branches of science and art to specific industries or employments. It does not include teaching the practice of any trade, industry, or employment, but does include instruction in the branches of science and art with respect to which grants are, for the time being, made by the Department of Science and Art, and any other form of instruction (including modern languages and commercial and agricultural subjects). It will be seen from this definition that the aim is rather to teach principles and methods than to give instruction in the actual mechanical manipulations

required in the various arts, crafts, and trades, which are better learnt in the workshops. Next come distinctions. These have to be drawn on both sides of the broad definition, so that it may not clash with existing conditions of trade and education. This is done by limiting the instruction to industrial subjects as much as possible, keeping in view the after career and future livelihood of the pupil.

With the exception that no part of the Council's funds may be expended for the instruction of children who are in the standards of an elementary school, it is allowed a very free hand with regard to the direct supply of Technical Education. An account of their Powers is given in the Report, where also will be seen their relation to the Science and Art Department.

Perhaps the most interesting part of Mr. Llewellyn Smith's work is the graphic representation of existing needs, giving the localities, over London, in which the more important trades have their centres, and showing where schools would be most advantageously placed. The geographical distribution of industries appears in a series of maps, the shading of which illustrates the percentage of population engaged in the particular trade. The *data* for these maps are derived from the returns of the 1881 census, those of 1891 not being yet available. From the figures it appears that domestic service employs 300,000 persons in London, which here, as elsewhere, stands far ahead of any other single industry in point of numbers. The clothing trades account for 220,000. The largest group of skilled trades in London is the building trades, in which a total of 136,000 men and boys are employed. Next come clerks, of whom there are over 100,000, and these in turn are followed by the wood and furniture trades with 60,000; the engineering and metal trades with 53,000; and the printing trades with about 50,000. With regard to the position of technical colleges, it is pointed out that they should be placed near the homes, rather than around the workshops of the people.

Given the schools rightly located, equipped, and filled, where are we to look for efficient teachers? It is the vexed question as to whether the teacher should be a trained school-man or a practical worker. Mr. Smith's ideal is a skilled mechanic who has been taught to teach by a specialist in the art of teaching. This is undoubtedly a possible expedient for creating the instructing material, but we are inclined to think that, at the present rate of remuneration of science teaching, very few skilled mechanics will be found who would be willing to leave their workshops for the technical college. England is not so far wanting in capable teachers of technological subjects as seems to be imagined, if only a respectable salary were held out to them. With a few brilliant exceptions, the amount offered for teaching at these institutions is far too little, and good men are forced into commercial lines who would be admirably adapted to tutorial work.

Skilled mechanics are not the sort of fellows to appreciate being taught to teach, and even if they had the time to devote to the matter it is doubtful whether they could ever be "advised to take advice," without feeling more or less insulted. To some men teaching comes, as it were, by nature, and in others it can never be induced; to the former, instruction in the art is all but superfluous, and to the latter it is absolutely valueless. If existing universities count for anything, in the educational supply, they ought to be able to provide the necessary stuff, or else be modified until they can. The place for the skilled mechanic is the workshop, for around him are the actualities; in the class-room he is lost for want of them, and he has not the clear idea of principles that a school man is supposed to have. We know the fallings short of the professional, the orthodox instructor; he is too old fashioned and too impracticable. He discourses on principles rather than machines—principles are so old, machinery is so new. They are ignorant of the routine and conventions which are the dollar-making devices. Some men *deal* with their subject, others *teach* it; and thus, between Pluto and Plato, stands the pupil, to burn or to freeze. Technical Education for England by all means, but let it not be too "dull-mechanic." We cannot compete with Germany and America in that quality of human nature. The definition adopted by the London County Council, if acted upon, is well calculated to protect us in this regard.

THERMAL STORAGE.

The attention of electrical engineers has lately been directed by Prof. Unwin, in his Howard lectures, to the subject of the storage of energy, and particularly to its storage in the form of heated masses of water. The highly fluctuant load diagram shows the need of some reservoir in a central station wherein a surplusage of energy may be kept in readiness for use in times of great demand. By running the engines and boilers at full and steady load much more economical results can be attained than if their performance is made to follow implicitly the irregularities of the load line. With a reservoir of sufficient capacity the engine and boiler plant may be set to store the surplus energy during hours of light load, and may be run in parallel with the reservoir during hours of heavy demand. Such is the economic principle of storage. But the application of this principle involves difficulties. To whatever form of energy in nature or in artificial plant we turn for economic storage, we are met by the most deplorable losses, and sometimes by almost ruinous first costs. The principal modes of storing energy for practical use are as follows:—Pumping water to a high level, fly-wheels, compressing air, raising masses of metal (as in clocks), coiling springs of elastic metal, dissociating chemical compounds (as in storage cells), and the method under our especial consideration in this paper, viz., thermal storage.

When a mass of water is heated to a temperature above 212° F., it must sustain a pressure not less than the pressure of saturated steam at that temperature. The relation between any given temperature of water and the pressure of the steam which it supports is given by Regnault in his famous table of the properties of saturated steam. If, then, a closed vessel, and one capable of standing the pressure, is filled with water at a high temperature, and if some of this water is drawn off into a space where the pressure is less than the pressure corresponding to this temperature, the water will immediately boil, and will develop steam at a rapid rate, until there is established over the surface of the water a new pressure which is in perfect correspondence with the temperature. For example, if an enclosed mass of water is raised to a temperature of 406° F. it will exert a constant pressure of 260 lbs. per square inch, even though not a particle of steam exists in that space. But let us suppose

that steam does exist in a part of that space, as it does in an ordinary boiler, and that a large amount of this steam is suddenly withdrawn by the engine. Instantly the pressure falls; but, as it does so, the water evaporates into the steam space tending to keep up the pressure. Some of the heat becomes latent, by virtue of the change of state and a fall of temperature takes place, the new pressure and the new temperature adapting themselves to a condition of equilibrium. If we assume the pressure to fall so much as to 250 lbs. per square inch—an unusually large drop—then each pound of steam which would be produced would require on an average 830 thermal units. Now, the fall in temperature corresponding to the difference between steam at 260 and at 250 lbs. is 3·4 F., so that each pound of water would give up 3·4 thermal units, and 244 lbs. of hot water would be required for every pound of steam generated.

Examined in this light, it is seen that the problem of thermal storage is simply the problem of selecting a sufficient amount of *water room* in the boiler. This water room acts as a sort of fly-wheel, its thermal inertia carrying on the equilibrium of things when there is any sudden change in the demand for steam. It is interesting to note that this is what the problem really resolves itself into, for electrical engineers have been in the habit during recent years of decrying roomy boilers, and have been at great pains to show that the smaller the water room the better the boiler is adapted to their central station requirements. Moreover, it cannot be gainsaid that central station boilers are, as a rule, very much starved in the matter of water room. That a great mistake has been made in thus reducing the water space to the smallest safe figure we firmly believe, and the fact that hot water is so elastic a means of storage is in support of our conclusions.

In Mr. Druitt Halpin's scheme, described by Prof. Unwin, it is proposed to store water at 406° F., in steel cylindrical tanks, which would be supplied from ordinary boilers. From these tanks the steam would be drawn off through the main steam pipe, at as rapid a rate as might be necessary to meet the demand. The result of this would be that the water would evaporate, would fall to 347° F., and would develop steam varying from 250 lbs. down to 130 lbs. pressure. The water would never be allowed to fall below this temperature, because steam at 130 lbs. would be employed for working the engines, the steam being throttled down to that pressure when above it. The water at 347° F. would be re-heated by the boilers, and passed back again to the tanks. The whole plant is practically a large boiler, or set of boilers, with plenty of water room in the form of auxiliary domes or drums.

As to the cost of this scheme as a system of storage, it compares very favourably with chemical storage cells. Prof. Unwin states that the cost of plant would be about £1·64 per B.H.P. with condensing engines, or £2·24 with non-condensing engines, as compared with £8 for battery storage. In regard to working costs, it ought not to be found very wasteful to keep a mass of water at this high temperature, provided ample lagging is placed on the outside of every hot surface. The efficiency would at any rate be as high as that of storage cells working with the same variation of output.

The extremely wide range of output which this system is capable of, and the rapidity with which it adapts itself to sudden changes in demand for power, would render it especially serviceable in those generating stations, such as tramway generating stations, where a change of several hundreds per cent. in the output may take place at a few seconds' notice. To cope with such extreme cases as these, all such means of storage as fly-wheels, quick-steaming boilers, secondary batteries, or auxiliary engines are utterly unavailing. Possibly thermal storage may be found to be a successful solution of this great difficulty in electric power supply.

Advantages of Forcing Lamps at the Expense of their Life.

MR. CARL HERING has an exceedingly interesting, not to say important, article in the *Electrical World* for December 24th on this subject. After pointing out the well recognised fact that a definite degree of incandescence is necessary to give the maximum amount of light at the least cost, he proceeds to describe a method devised by Mr. O'Keenan for calculating what this efficiency should be. The method, which is unfortunately scientific rather than practical, rightly takes into account the diminution in illuminating power which occurs through blackening of the bulbs, &c., in addition to the cost of the electrical energy consumed, and of the lamps. For details of the method we must refer those readers who are interested to the article under consideration, but we may here say that it is based on deducing a curve showing the actual cost of the candle-power at each hour throughout the life of the lamp from two original curves, obtained experimentally, showing, firstly, the consumption of energy, and, secondly, the candle-power emitted throughout the life of the lamp. As a result of these calculations for different classes of lamps, it has been found that it is politic to discontinue running them after a much shorter period than it has been customary to suppose. Naturally, the time varies with the cost of lamps and electrical energy, and also with the make of the lamp, since changes in resistance and in blackening are not alike in all classes of lamps; but in no case does the critical point of maximum economy, or "smashing point" as it is proposed to term it, appear to extend beyond about 500 hours, and with some descriptions it is as low as 200 hours. The point that Mr. Hering wishes to bring out is that since the life remaining in the filament is of no value after this critical point is past, it is highly desirable to start running the lamps at a higher efficiency than is customary, seeing that an increased proportion of light is thereby obtained for a given consumption of energy. Although we admit the force of this argument, we also think that there would be more grumbling amongst householders, who would thus have to put up with, comparatively speaking, a rapidly dwindling light by which to work or read; and some may be ready to pay a little more for greater constancy of light. There is also another matter to be considered, especially from the lamp manufacturers' point of view and that of the householder who has to buy lamps, viz., that a higher efficiency entails a smaller radiating filament surface. Now, in England, the ordinary electric supply is 100 volts, and the lamps in almost universal use are of 8 C.P., running at about 5 watts per candle (actual). To increase this efficiency to, say, 3 watts per candle (actual) would necessitate a decrease of illuminating surface of some 60 per cent., and this is rather a heavy amount on an already pretty fine filament. It is well known that very fine filaments will not live as long as more substantial ones, and owing to breakage, &c., such lamps cost more to manufacture. So that, from this point of view, it is undesirable to push the incandescence too far, for the average life would then cease before the "smashing point" arrived.

INTERNAL TRANSMISSION OF POWER.*

By B. H. THWAITE.

Comparative Efficiencies of Internal Power Transmission Arrangements.

The importance of the subject of the transmission of dynamic force to motive elements constituting the industrial plant, has only quite recently received some of that recognition which it deserves. The absorption of energy by shafting and belts is not even now properly appreciated. It is only when the dynamometer has been applied, and, better still, since direct driving by electric motors has displaced shafting gearing and belting and other methods of driving—generally in use, that power users have realised the degree of ceaseless waste in their methods of power transmission.

The author has built up a diagram, based on some data obtained from Mr. H. Flather's recent work on "Dynamometers and the Measurement of Power"†—a work that should be in the hands of every power user. This diagram alone is a lesson to engineering students.

The displacement by direct electric driving of ordinary shafting and belting methods has resulted in that reduction of power absorption very considerably.

M. Sarteaux, Engineer of the Chemin de Fer du Nord, has recently introduced electric driving at the locomotive workshops at Creil, and he has informed a mutual friend that he has realised a saving in power of 50 per cent.

This friend, in a letter, tells the author that some investigations carried out at the Fabrique d'Armes de St. Etienne proved that with their then shafting and belting methods of power transmission, not more than 7 per cent. of the power consumed is utilised in doing actual work.

What is the explanation of this extraordinary waste which, if summed up for all our industrial applications, would almost turn the hair of our patriot economists grey?

One may venture to suggest an answer—

The main shafting, having a potential of dynamic energy equal to the maximum requirements, is always in motion, each bearing surface in its length having a function of energy absorption depending in value upon the character and nature of the frictional surface.

Each location of transmission by belting to counter shafting is also a point of energy absorption, whether the effective part of the producing plant is in operation or not.

In dust-producing workshops the friction produced by the deposition of dust on the bearing surfaces, is alone a factor of explanation, and the loss of efficiency by imperfectly light and unsuitable belting and intra methods of power distributing is also another factor.

The gearing elements for diverting the line of power transmission are also absorbers of energy.

Individual machines absorb much less power than is generally supposed, and the author urges every power user to ascertain precisely the amount of power absorbed by each of his machines. He would then be cognisant of the running loss by which he is the sufferer.

Since the author wrote the above he has seen the advance proofs of Mr. Saxon's useful paper. Mr. Saxon pertinently remarks that if the coal consumption were based on actual work done it would give some startling results. There is little doubt but that M. Sarteaux's happy experience of a power saving of 50 per cent. by the application of direct electric driving would be experienced by many engineering workshop owners.

In Mr. Saxon's summary of tests it appears that the average energy absorption percentage for—

Spur geared driving is	...	...	...	25·9
Rope do. do.	...	...	...	29·6
Belt do. do.	...	...	...	28·6
Direct coupled do. do.	...	...	...	23·835

giving a total average of 26·983 per cent. of energy absorbed in internal power transmission work.

On referring to the diagrams of loss of energy, in electric transmission methods, it will be realised that for any ordinary works there would be practically *no loss* of energy between the motor and the subsidiary industrial machine.

The relatively high speed of electro-motors is, unfortunately, not appropriate to existing stationary tools except by the employment of reducing motion pulleys; but there is no obvious reason why the electric motor should not be applied direct to each new and convertible machine, the speed being reduced by helocoidal or other appropriate gear, to satisfy the requirements of the industrial operation.

Granting this desideratum, we have at once an ideal method of transmission which has the following series of valuable characteristics:—

1. Each industrial machine can be easily and instantly thrown out of dynamic action by the simple touch of a switch.
2. The loss of efficiency in power transmission from the parent motor is almost negligible.
3. No lubrication is involved, nor expensive lubricants.
4. The dangers associated with belt shifting and belting set forth graphically in the author's work, "Our Factories, Workshops, and Warehouses," is entirely removed.
5. In the event of an accident the machine can be instantly arrested.
6. As the power demand is cut off, the power supply is reduced in the same ratio.
7. The position of the machine can be altered in any direction considered convenient, without involving the consideration of its effect upon the line of transmission.
8. The danger from fire through over-heated bearings is reduced in a degree depending upon the quality of insulating workmanship and upon the character of the fusible cut-off.

The employment of internal electric transmission has been in no instance in this country more fully put to regular use than by the famous firm at Wolverhampton—the Electric Construction Corporation, Limited; and for this progressive action we may thank Mr. Thomas Parker, than whom there is no more enthusiastic advocate of the practical advantages of electricity. Thanks to the courtesy of this firm, we are enabled to realise the extent of their practical patronage to electrical methods of power transmission. The full particulars are given in the appendix; but it may be stated here that *with the exception of one defect, that of the retention of intra or subsidary shafting and belting*, the whole of the power is transmitted electrically. The motors are distributed over four acres of ground, the same cables distributing and transmitting the current for the motors, also supply the arc and incandescent lamps for lighting the works.

All the machine tools, with the exception of a large planing machine and circular saw (which have a motor of their own) are driven from shafting, rotated electrically. The 10-ton shop crane is also electrically driven. The cranes travel up and down the shop at the rate of 50 feet per minute, and cross the shop at the same speed.

The electric transmission plant has now been running for two years. So far, there has not been any accident, and beyond the usual brush renewals for generating machines and motor transmitters, there have been no repairs required.

The firm completely relies on its motors, and has not provided any other means of driving the tools.

Not having driven the works by the ordinary methods, the firm cannot make any direct comparison as to power required, but the secretary writes that there is no doubt but that a comparison would come out largely in favour of the electric method.

The De La Veigne Refrigerating Machinery Company, of New York City, have applied in their new works the electric method of transmitting power. They drive their extensive series of planing, slotting and drilling tools by separate motors of approximate size, gearing down by countershaft and belt; even with this disadvantage they consider that at least 7 per cent. of efficiency is gained, and the cost of maintenance is considerably less.

Particulars of Electric Transmission of Power Plant at the Electric Construction Corporation's Works, Wolverhampton.

Electric Generators.—Two shunt-wound dynamos, each capable of giving 110 volts, 750 ampères, at 400 revolutions. The lighting of the works is supplied from the same dynamos as the power. During winter months, when the

* Appendix to Mr. Thwaite's paper on the Transmission of E.M.F.

† "Dynamometers and the Measurement of Power."—Flather.

lighting plant is in action, the two dynamos are run in parallel, but for supplying power only one machine is ever in action.

Electric Motors.—The following is a list of the motors in use :—

Three motors are driving 10-ton travelling cranes.
Two „ „ 5 „ „
One motor is „ a Root's blower supplying air blast to cupolas and Smith's hearths.
One motor is driving a circular saw.
One „ „ planing machine.
Nine motors are driving the counter-shafting from which the tools are driven.
Two small motors, one for driving a small lathe and drills for instrument making, and the other for polishing bobs.

Electric Power Distribution.—The motors are distributed over about five acres of ground. The same cables that lead the current for the motors also supply the arc and incandescent glow lamps for lighting the works.

Counter Shafting.—All the machine tools, with the exception of a large planing machine and one circular saw (each of which have a motor of their own) are driven from counter-shafting, which is 2½ in. diameter throughout. The main lines of shafting are about 250 feet in length, on each of which there are two motors. These motors run at a speed of 500 revolutions per minute, and drive by belt on to the counter-shafting, which runs at 120 revolutions. The motors share the load, and regulate themselves. The length of shafting at present in use is some 1,200 feet. There are 164 tools driven from shafting, many of them being very large.

Voltage and Ampèrage Power.—The average output from the electric generator supplying all the above motors, is 110 volts, 500 ampères.

Cranes.—The 10-ton cranes are arranged to travel up and down the shop at a speed of 50 feet per minute, and across the shop at the same speed. With the fast gear they lift at a speed of 9 feet per minute, and with slow gear at 4·5 feet per minute. Some tests taken soon after the cranes were erected, and with all parts new, gave the following figures :—

Lifting 7 tons, slow gear motor absorbed	70	ampères	106	volts.
Lowering 7 tons slow gear motor absorbed	23	„	108	„
Lifting empty, rapid gear „ „	18	„	110	„
Lowering empty rapid gear „ „	8	„	110	„
Travelling along the shops „ „	20	„	109	„
Lifting 9 tons, slow gear „ „	110	„	105	„
Lowering 9 tons, slow gear „ „	50	„	110	„
Travelling along shops with 9 ton load	25	„	110	„
Travelling across „ „ „ „	25	„	110	„

Planing Machine.—A large planing machine, capable of planing 20 feet by 12 feet by 8 feet high, and having a travelling table weighing 17 tons, is driven by an independent motor. When planing up an ordinary bedplate casting, the electric energy taken in forward cutting averages some 105 volts 30 ampères, and absorbs slightly less than this on the return motion, but at the moment of reversal at each end of the travel, the power absorbed increases to 105 volts 100 ampères.

General.—The electric transmission plant has now been running in these works for almost two years. So far there has not been any accident, and no repairs have been as yet required beyond the renewal of brushes for the dynamo and motors.

Electric Locomotive.—There is a small electric locomotive in use on the surface at a colliery in the neighbourhood of Wolverhampton. The current is supplied at a potential of 300 volts by means of a bare copper wire (4 gauge) carried by insulators from poles ; the return circuit is made through the ordinary rails. The power is nominally equivalent to 9 H.P., but the machine works up to twice this power for short periods when taking a heavy load (six tubs) up the steepest gradients.

Additional Notes re Loss of Dynamic Energy in Internal Transmission of Power by Belting and Gearing.

It is stated by Flather that in shops using heavy tools, the percentage required to drive the machinery will average from 40 per cent. to 50 per cent. of the total power expended ; this involves the inclusion of elevators, fans and blowers.

In shops using lighter machinery, and having a connected foundry, the power percentage will be about the same ; but without the foundry, the expenditure of power in transmission will fall between the figures of 30 per cent. and 40 per cent.

The elements of loss are—1st, belts running on loose pulleys ; 2nd, numerous clutches ; 3rd, numerous counter-shafts ; 4th, points of flexure ; 5th, inadequate lubrication.

The American machinist, Babcock, states that for ordinary work, 1 H.P. is sufficient to drive machine tools necessary to keep 10 men well employed. In two instances quoted by Flather, one (Brown and Sharp Manufacturing Company) employ 3·91 per H.P., the other (Pratt and Whitney) employ 6·04 per H.P. Both works turn out the same class of work. In one instance (the Baldwin Locomotive Works) the power absorbed is 80 per cent. Henthorne considers, however, that shaft absorption should not exceed 19 per cent. of the initial power.

In the New England Cotton Mills the shaft power absorption is said to vary from 18 per cent. to 25 per cent. ; so that with electric transmission we have, in the examples given, a possible margin of saving varying from 16 per cent. to 75 per cent.

RESEARCHES ON POLARISATION.

DURING the last two or three years a good deal of research has been carried on by C. Fromme, from the results of which he has concluded that with great current density strong polarisation appears at small electrodes [*vide* papers in the *Annalen der Physik und Chemie* [2], xxxviii., p. 362 ; [2], xxxix., p. 187, &c.] On the other hand, F. Richarz has deduced from his investigations on the same subject that the polarisation does not alter with the current density, but that the resistance in the electrolyte does. [*vide Annalen* [2], xxxix., p. 201]. Richarz used the Helmholtz pendulum contact-breaker for measuring the polarisation after the polarising current has been interrupted.

The discrepancies in connection with these investigations have led to a re-examination of the whole question by K. R. Koch and A. Wüllner, who employed a new method of measurement. They observed simultaneously the current strength, the differences of potential of the electrodes, and also by an electrometric method, the polarisation at each of the small electrodes. From the data thus obtained, they were enabled to calculate the resistance of the electrolytic cell.

The first portion of a paper in a recent number of the *Annalen* is devoted to a tabulation of the results of this research, in which solutions of sulphuric acid, of various densities, were employed, and the electrodes were of various shapes and sizes.

In the second portion of the paper, which may be consulted in full in the *Ann. Phys. Chem.* [2], xlv., pp. 759—797, the first portion being in [2], xlv., pp. 475—507, Koch and Wüllner give an interesting account of their investigations on the phenomena of "current reversal ;" that is, the sudden reduction of the direct current and increase of polarisation ; this is produced by increasing the strength of the current beyond a certain limit.

A large number of experimental data were obtained in carrying out the examination, and these are arranged in the form of tables. But one of the most interesting features of the paper is, perhaps, the drawings from instantaneous photographs, which show the evolution of gas and other physical appearances at the electrodes, under such conditions as the current below and above the limit for reversal.

Space will not allow of our alluding to more than the deductions which were arrived at concerning this galvanic polarisation at small electrodes ; these may be briefly summarised as follows :—

(*a*) At short electrodes, consisting of platinum wire immersed in dilute sulphuric acid, there exists a polarisation which increases considerably as the strength of the current is raised.

(*b*) This polarisation is the result of an electromotive difference of potential which is opposed to that of the direct current and of the resistance of a layer of badly-conducting

gas which adheres to the electrodes. The electromotive force of polarisation does not depend upon the length of the wire electrodes, nor, generally speaking, on the degree of concentration of the electrolyte; it has the value 3·97 volts, to which the polarisation of large electrodes with increasing current density approximates.

(*c*) The layer which forms around the electrodes is transitional, and its resistance is not dependent upon the strength of the current with given electrodes and electrolytes. It is proportional for the same pair of electrodes to the specific resistance of the electrolyte; for the same solution this resistance diminishes according as the length of the electrodes is increased.

(*d*) The rules thus enumerated only hold for strength of current below a certain limit, which depends on the length of the electrodes and on the conductivity of the liquid. When this limit is reached, an increase of the E.M.F. causes the so-called "reversal." The current becomes very weak if the polarisation at the smaller electrode be suddenly increased. The strength of the residual current is not increased by an augmentation of the E.M.F., and it is greater in the case of long wire electrodes than in the case of short ones.

(*e*) If the "current reversal" be brought about by great polarisation at the anode, this electrode will become incandescent; it will sometimes split, and may even be completely disintegrated; should the seat of "current reversal," however, be at the cathode, a curious bluish-white glow will surround this electrode, due, probably, to the gaseous envelope; the wire may become incandescent, but is never destroyed, as in the case with the other electrode.

(*f*) A polarisation which increases with the strength of the current takes place in the case of zinc electrodes in zinc sulphate solution, also with copper electrodes in copper sulphate solution. A sudden increase of this polarisation at the anode occurs with a given strength of current, and this great polarisation can also be obtained at large anodes even with a small current density, by producing it in the first place at a small portion of the surface by means of a large current density.

INCREASED COMMERCIAL EFFICIENCY AND HIGHER ECONOMY IN CENTRAL STATIONS.

AN admirable series of articles on "Central Station Economy," by Mr. J. H. Vail, has appeared in the *Electrical Engineer*, of New York, in which he deals with the subject from an engineering point of view, and chiefly in connection with the generating plant.

The conditions, however, with which electric power stations have to deal in the United States, differ in many respects from those prevailing in Great Britain, and perhaps it would be as well to point out a few of them. In the first place the Americans have not the system of paternal government which exists in this country, under which the Board of Trade has a very considerable voice in the arrangement of electrical plant and supply of current. Public supply stations in England are bound under penalties to maintain within four per cent. of a given standard pressure, which pressure has been officially declared with the sanction of the Board of Trade previously. Also by the Electric Lighting Acts, 51 Vic., the local authorities are empowered to buy up any plant after 42 years from the granting of an order.

The overhead system of conductors are also practically unknown in this country, thanks to the almost prohibitive condition imposed upon them by the Board of Trade, by which the most fruitful source of accidents in America is obviated here. These regulations all tend to make the starting of a company in England a more difficult matter, and the result is that when the company is finally established it is generally on a much more substantial basis than would otherwise be the case.

This construction for permanency gives them at the commencement the elements of commercial success, and it remains after this, largely a question of efficient management, to give good and satisfactory results.

Electric lighting has been much slower to take root in this country than in America. This is largely due to the comparative newness and rapid extension of American towns and the fact that gas is used in this country, and electric lighting has to compete against it, whereas in a new country it is a question which of the two to employ. Most of the gas used in the States is either of inferior quality or very expensive as compared to that in this country, also the question of labour is a much heavier item. The competition therefore has not been so severe there. Here also it is much easier to know what will probably be the maximum output required and to design the station accordingly. The system of employing cheap and inexperienced labour, and what he terms "Cheap John" construction, meets with Mr. Vail's severest condemnation, and he gives the Europeans credit for the much more permanent character of their work. However, depreciation must come in as a considerable item with even our permanent class of work, and 10 per cent. is a reasonable estimate to allow for the engine and boiler plant, which plant must be kept in first-class condition to ensure at all economical working. This takes us direct to fuel consumption, which is the commencement of the ordinary expenses after the first initial cost of plant, &c., has been met. The devices for securing economy of fuel are legion. In many of them the greatest claim on our attention is the ingenious manner in which they are advertised. There should be on the staff of every central station at least one man who is thoroughly conversant with the theory and practice of the steam engine, not merely as knowledge gained from textbooks, but by long experience as well, and to this man should be entrusted the examination and selection of the best of these appliances, subject to the approval of the general management. We should then hear less complaints as to losses and inefficiency. Specialisation is the order of the day, and it applies to central stations with equal force as to any other trade or profession. Mr. Vail also recognises the fact that whilst automatic appliances save labour largely, they can never do away with close personal supervision. We believe that in this country the responsible engineer-in-chief of most central stations is chosen more on account of his electrical qualifications than his engineering ability, hence the greater necessity for additional engineering talent. There are some notable exceptions to this rule, and according to the tables published in the ELECTRICAL REVIEW, the company showing the least expenditure of fuel per kilowatt hour is one superintended by a well-known professor of engineering, who is none the less an engineer. Many English companies would do well to make a note of this. Mr. Vail hopes to attain an economy of 1·3 lbs. per I.H.P. hour, with quadruple expansion engines. Whilst this may be obtained with the best quality of American coal, some of which we have found from personal experience to be equal to the best Welsh, the ordinary American "slack," as it is termed, will not probably give those results, especially as central station work is too variable in its character for the engines to work at the most economical rates. English practice at present varies from 5·7 lbs. to 25 lbs. per unit, which, as compared with Mr. Vail's assertion of 3 to 8 lbs. per I.H.P. giving 75 per cent. efficiency between the electrical and the indicated H.P., is equivalent to about 5·3 lbs. to 15 lbs. per unit. This shows slightly in favour of American practice. Mr. Vail suggests the utilisation of the hot air of engine and boiler room as hot air supply to furnaces; but if the boilers be properly protected by asbestos or other non-conducting substances, the gain from this must be very slight.

The want of an efficient lubricant appears to be Mr. Vail's chief objection to the use of quadruple engines for very heavy constant loads, but unless much higher pressures than 200 lbs. be used, we believe there is no serious difficulty with the mineral oil lubricants at present in use, and the use of lubricants in the cylinders of engines is very much overestimated. Many triple expansion engines run for weeks without other lubrication than that afforded by the steam, and by the little oil making its way in from the piston rods, greatly to the advantage of the boilers in the case of surface condensing engines.

Next in order comes the suggestion that engines of highest economy, as well as of powers ranging upward from 500 H.P., will be the future practice in the U.S. With regard to the engines of highest economy, they must result in a saving in all cases where fuel is of importance, but the present English practice is not in favour of units ranging more than from 100

to 450 H.P. This allows for the duplication of generating units, and a reserve plant is always available, so that one engine may be disabled without interfering with the general supply, tending to secure that absolute reliability which he justly deems to be an essential element of success in electric lighting. Mr. Vail also points out the necessity of having the engines exceptionally well proportioned and heavy. This applies more particularly to American practice than with us. The appliances generally used by Americans are much lighter in their parts and construction than the English practice, but that the service is more stringent than that required for ocean steamers, it is difficult to admit. In most stations the engines are all stopped for a large proportion of the day, and any examination or adjustment can easily be made, and no stations work continuously for full loads, whereas, in ocean steamers, many run for 21 days and upwards without stoppage or the slightest chance of adjustment. In other respects the conditions relating to the care of a station, as far as the terminals of the dynamo, are very similar.

Mr. Vail then goes into a question of economy of compounding and condensing. It seems that great economy should be obtained by the exhaust steam from all the various engines being taken to surface condensers arranged to suit the varying work. This gives a good supply of pure water for the use of the boilers and largely tends to prolong their life. This is of course only available when sufficient water is obtainable. However, no fixed laws can be laid down to apply in this country more than in any other, as almost every station works under different conditions.

Engine friction next occupies Mr. Vail's attention, and a series of tests are given, but they rather lack interest from the want of detailed particulars as to pressure, &c. It may be interesting to point out that the present practice in the U.S. Navy is to disconnect the L.P. cylinder when running the engines at low speeds, as it is found that there is considerable advantage in so doing. In one instance in our experience on land an apparent saving of 10 H.P. out of 65 H.P. resulted from this course. This may be found to be useful in certain cases in large power direct coupled dynamos.

Full load is the most economical method of running engines usually, but it must be remembered that, although a nearer approach to full load working of all engine and dynamo plant is obtained by carefully adjusting the size of the unit, still a fair margin must be allowed in running for the increase of demand and this limits the nearness to the full working power to which it is safe and prudent to go. In running alternators in parallel, as is the growing practice in this country, still greater margin must be allowed to permit of the synchronising energy coming into play when necessary without actually overloading the higher voltage machine, or when large capacity exists in the mains, the laggard.

On American stations, where such parallel running is not generally practised, and most of the stations are on the high tension alternate current system, it is hard to see how any case can be made out to prove an efficiency anything approaching that claimed by Mr. Vail and mentioned in the previous part of this article.

In connection with feed-heating it should be pointed out that whilst, when properly managed, it is a great saving in fuel, that the heating of the feed at the expense of the funnel gases as used in some stations, may be carried out to such an extent as to very seriously diminish the draught, and consequently the effective evaporative power of the boilers.

English central station engineers will certainly agree with Mr. Vail when speaking of direct coupled plants. He says that higher commercial efficiency will be gained, and this is a point to which we are glad to see our friends in the United States are directing their attention. It is not a little curious that although the first large plant turned out by Edison himself was direct coupled, the Americans soon deserted their first love in favour of many others, with varying success, to find out that the old love will probably be the best.

As to direct coupling, it will be not a little interesting to note the outcome of present designs of direct coupled alternating plant, such as that in hand for the City of London Company, as some others have not had quite the success desired. In conclusion, Mr. Vail's articles may be read with considerable advantage by English engineers, and allowing for the difference between American and English practice, they would do well to follow his well-tendered advice.

THE RELATIVE ADVANTAGES OF CONCENTRIC AND DOUBLE CABLES.*

BY MORTON E. EDEN.

As concentric cables are rapidly coming into use, especially for high pressure alternating currents, it would be interesting to hear from some of your readers their experience as to the durability and advantages discovered.

The relative merits of concentric, as compared with two separate cables, have attracted a great deal of attention abroad, where they advocate their use for high pressure alternating currents. Of course, there is a great deal that can be said against their use, but then again there are no doubts as to the advantages attained, for instance as regards the question of induced currents in neighbouring wires, for as long as the insulation is good, there is no induction, owing to one conductor being concentric with and enclosed by the other. This is very important when telephone, telegraph and other wires are run parallel with, and in close proximity to, alternating circuits.

Of course, with two separate cables run close together, as for instance in the same conduit, no trouble would be experienced from induction; but, two separate cables do not, as regards their insulation, stand the strain of pulling in so well as a concentric cable, because it matters very little if the insulation on the outside of a concentric cable is slightly damaged.

As to safety to the linemen and public, the concentric cable is undoubtedly better under certain conditions of working, than two separate ones, for if the capacity of the outer conductor with regard to the earth is considerable and the insulation of all parts of the circuit is good, the mean potential of the conductor is the same as that of the earth, and the greatest difference that could exist between the two is that due to fall of pressure, caused by the flow of current in the cable. But if the circuit is faulty, in the converter or at any fitting, the point at which the leak occurs will be of the same potential as the earth, and these no doubt will show under given circumstances, a considerable difference of potential.

Mr. Ferranti, I believe, suggested a method of overcoming this difficulty, to ensure that only a small difference of potential can exist, by connecting them electrically at some part of the circuit, and he adopted it in the mains of the London Electric Supply Company, London, England, where with two separate cables laid underground, so that their outer coverings are earthed, the danger of a shock is removed, except when some part of the cable itself is touched. This same danger occurs in circuits where the cables are concentric, unless the concentric principle is carried through to all connections to converters, switches, &c. But the degree of safety obtained by the use of concentric cables over two separate cables is no greater unless the outside covering of the concentric cable is earthed throughout the whole system.

In concentric cable systems as regards testing of insulation, &c., a difficulty is met which is not experienced in a system of two separate cables, for when an insulation test between the two conductors of a concentric cable is required to be made, all connections between dynamos and other apparatus must be disconnected, which is hardly practicable.

As regards the use of lead covered cables for alternating currents, it seems that it would be best to use concentric cables, as with a single conductor cable there must be an appreciable waste of energy from induced currents in the lead covering, this waste does not occur in concentric cables. The higher the frequency, the greater the waste of energy.

Relative to jointing, greater, though not seriously greater, difficulty is met with than with single conductors, more especially with T-joints; but a special junction box will facilitate the making of most joints. It would be most interesting to hear more about the use of concentric cables and their advantages over two separate cables.

One company in London, England, is laying down concentric cables for the alternating system now being installed for the City of London lighting, some circuits having been in use for some months and no trouble whatever being experienced.

* New York *Electrical Engineer*.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

THE following is the report of the sub-committee on Provisional Programme for the International Electrical Congress of 1893, to the General Congress Committee of the American Institute of Electrical Engineers :—

Gentlemen,—The sub-committee on provisional programme respectfully submits to you the following report :—

DUTIES.—The sub-committee understands its duties to be as follows :—

To suggest what work it is desirable to have done at the coming International Electrical Congress to be held in Chicago in 1893.

To suggest a programme for carrying out this work in the most satisfactory manner to all parties, and with the least loss of time.

RECOMMENDATIONS.—Regarding the work to be done, your committee's recommendations are as follows :—

RATIFICATIONS.—(1). *Ratification of the adoption of units, terms, symbols and definitions by previous International Electrical Congresses.*

This is a mere matter of form and an act of courtesy to the preceding congresses. Your committee understands that this was done at both the Paris Congress of 1889 and the Frankfort Congress of 1891. (For the work done at previous congresses see Appendix I.)

NEW UNITS.—(2). *Defining and adopting practical units for measuring and designating the measurements of the following quantities: Magneto-motive force; magnetic flux; magnetic intensity; magnetic reluctance; electric conductivity; illumination.*

It will be noticed that this refers only to the question of what the magnitude of the units shall be, or, in other words, what multiples or sub-multiples of the absolute units they are to be.

Your committee is aware that objections are raised by some, to the establishment of units not already in universal use. Past experience, however, has shown that the proper time to establish units is *before* their need is universally felt, in order to avoid the introduction by different persons or nations, of units of different values, a contingency which will be very likely to arise if not anticipated by concerted action.

Your committee recommends the following :—

The value of the practical unit of magneto-motive force to be one-tenth of the absolute unit, that is, equal to $\frac{1}{4\pi}$ ampère turn.

The value of the practical unit of magnetic flux to be 10^8 absolute units or lines.

The value of the practical unit of magnetic intensity to be 10^8 absolute units, that is, 10^8 lines per square centimetre.

The value of the practical unit of reluctance to be 10^{-9} absolute units.

The value of the practical unit of electrical conductivity to be 10^{-9} absolute units, that is, to the reciprocal of the ohm. This makes it equal to the unit proposed some time ago and known to some extent by the name of "mho." It should be given this value in order that it may correspond with the already adopted units.

The value of the practical unit of illumination to be a bougie-decimale at the distance of one metre. The bougie-decimale is the unit of light or candle-power already established, and is practically equal to one English standard candle; by making the distance a metre, the practical unit will be approximately equal to one-tenth of a carcel-metre, one-tenth of a foot-candle (or "lux"), or to one metre-candle or metre-kerze, all three of which units are already in use to some extent.

It has been announced that a proposition will be made at this congress to change the values of some of the practical units which have been adopted by previous congresses and are already in universal use. Among these are the ampère and the farad. It is urgently recommended by your committee that such changes should not be favoured, since they would necessarily be followed by great confusion, and would of necessity have to be accompanied by some change in these well-established names in order to distinguish these new units from those now existing.

NAMES FOR UNITS :—(3). *Adopting names for the following practical units: Magneto-motive force; magnetic flux; magnetic intensity: magnetic reluctance; inductance; electrical conductivity; illumination.* The following names are suggested for these units:

For the practical unit of magneto-motive force, the name "gilbert."

For the practical unit for magnetic flux, the name "weber." This term was formerly applied to a unit of current, but its use in this sense was so limited, and it has been abandoned for so long a time, that no confusion would be likely to arise; the context alone would always be sufficient to prevent any possibility of misunderstanding. The name "weber" is preferred on account of the intimate relation between this unit and that of magnetic intensity for which the name "gauss" is suggested.

For the practical unit of magnetic intensity, the name "gauss." This name has already come into use to such an extent, that objections to it will not be likely to arise.

For the practical unit of magnetic reluctance, the name "oersted."

For the practical unit of inductance, the name "henry." This name has already come into use quite extensively, and it would therefore be very undesirable to change it. The value of this unit has already been fixed as equal to 10^9 absolute units, or nearly to the length of an earth's quadrant. The definition "quadrant" is sometimes employed as the name itself, but its use as a name is evidently objectionable, as it already has several other meanings, which might readily lead to confusion.

For the practical unit of electrical conductivity, equal to the reciprocal of the ohm, the name "mho." This name has been in use for some time, and is already well known. It is thought better to recommend it than to select and introduce a new name.

For the practical unit of illumination defined above, the name "bougie-metre."

It has been suggested to name the units "kilowatt-hour" and "ampère-hour." Your committee, however, recommends that inasmuch as these terms explain themselves, and are not longer than some others in use, to give them special names would burden a system of nomenclature unnecessarily. The principal objections to the term "Board of Trade Unit," which is in use in England for the former, are, that it could never become international, that it is longer by one syllable than the term "kilowatt-hour," and that there are now, or may soon be, units of other denominations adopted by the same Board of Trade, from which this one will have to be distinguished by an additional affix or prefix.

CONCRETE STANDARDS :—(4). *Defining and adopting modes of embodying the following principal units of measurement in concrete standards capable of being readily reproduced, and adopting names for them or for the theoretical units, by which they can be distinguished from each other:—Ampère, ohm, volt, watt, standard candle.* The following definitions of these units are recommended :

An ampère shall be that unvarying current, which, when passed through a solution of nitrate of silver in water, in accordance with the specifications recommended in the recent report to the British Board of Trade (See Appendix III.), deposits silver at the rate of 0·001118 of a gramme per second.

An ohm shall be the resistance offered by a column of mercury at the temperature of melting ice 14·4521 grammes in mass, of a constant cross-sectional area, and of a length of 106·3 centimetres. It is recommended that material standards of this value, constructed in solid metal, should be preserved under the care of the several governments, as standards of comparison, and that they should from time to time be verified by comparison with the mercury standard defined above; also that for the purpose of replacing the standard, if lost, destroyed, or damaged, and for ordinary use, a limited number of copies should be constructed which should be periodically compared with the standard ohm.

A volt shall be the product of this ampère and this ohm.

A watt shall be the product of the square of this ampère and this ohm.

The other units, such as the coulomb, the farad, and the joule, shall be taken as derivatives in terms of this ampère and this ohm.

In order to create as little confusion as possible by the introduction of this set of units which are to become the universal standards, and in order to distinguish them readily from the true theoretical, or abstract units defined in terms of the absolute units, it is recommended to call the former simply "ampères," "ohms," volts," &c., or more specifically "standard ampères," "standard ohms," &c., and to call the theoretical units "true ampères," "true ohms," &c. The latter term has already come into use in this sense.

The unit of resistance known as the B.A. unit, shall be taken as equal to 0·9866 of this ohm.

The electromotive force of a Clark cell at 15° C., prepared in accordance with the specification recommended in the recent report to the British Board of Trade (see Appendix III.), shall be taken as not different from 1·434 of these volts by more than one part in one thousand. The coefficient of temperature shall be taken as. . . . . ?

The standard candle shall be taken as equal to the light from a lamp like that known as the Hefner-Alteneck standard amyl acetate lamp, which is to be defined by its dimensions and the height of the flame, the dimensions being such that the light shall be equal to that of the "bougie-decimale," the practical unit adopted at the Paris Congress of 1889, which is equal to one-twentieth of the absolute platinum standard adopted in 1884.

It has also been suggested that a universal wire gauge be defined and adopted. Desirable as this may at first seem, your committee recommends that no action be taken by the Congress in this matter, as it is not likely that any one scale would ever be universally adopted by manufacturers, even if defined and adopted by a Congress. The universal introduction of the metric system and the designation of wires by their diameters in millimetres, is thought to be the only satisfactory solution of this question for international work.

NOTATION AND SYMBOLS.—(5). *Adopting an international system of notation and conventional symbols, for designating different quantities.*

The system suggested to the last Congress by Mr. E. Hospitalier, of Paris (see Appendix IV.), is recommended by your committee, although doubtless some amendments may be found desirable.

DEFINITIONS.—(6). *Defining the following terms :—Impressed electromotive force, inductivity inductance, reluctivity, Matthiessen's standard, north and south pole.*

The following definitions are suggested :—

The impressed electromotive force is the ratio of the total activity in an electrically conducting circuit to its instantaneous current strength.

The inductivity at any point in an isotropic medium is the ratio, added to unity, of 4 π times the intensity of magnetisation there existing, to the magnetising flux density. Inductivity is synonymous with "permeability." The electro-magnetic dimensional formula is $L^0 M^0 T^0$; the conventional symbol is μ.

Inductance.—(*a*) Self inductance is the ratio of the total magnetic induction linked with and established by an electric current, to the uniform strength of the same. The inductance of a conducting circuit is constant when its environing medium has constant inductivity. (*b*) The mutual inductance of one electric circuit upon another is the ratio of the total magnetic induction linked with the second, due to a uniform current in the first, to the strength of that current. The mutual inductance between two electric circuits is reciprocally equal when the environing medium has constant inductivity. The electro-magnetic dimensional formula is $L^1 M^0 T^0$. The absolute unit is one centimetre ; the practical unit, one henry.

The reluctivity of a medium at any point is the volume differential of the reluctance thereat. Simple definition : Reluctivity is the reluctance per unit volume. The electro-magnetic dimensional formula is $L^0 M^0 T^0$. The absolute unit is one C.G.S. unit of reluctance per cubic centimetre ; the proposed practical unit is the same or about one oersted per cubic earth quadrant.

The resistance of copper known as Matthiessen's standard shall be defined as follows :—The resistance of a soft copper wire one metre long, weighing one gramme, is 0·14365 B.A. units at 0° C. This definition is recommended by the Committee of the American Institute of Electrical Engineers on Matthiessen's Standard (see Appendix V). The reasons for selecting it are given in that report.

The north pole of a magnet to be defined as being that which seeks the geographic north pole, and the south pole that which seeks the geographic south pole. This is the generally accepted definition, but it is thought desirable to formally define it.

EXPRESSIONS.—*Defining and adopting expressions :—For alternating currents of more than one phase : for describing phenomena of alternating currents and of electro-magnetic waves.*

It is recommended to adopt the following expressions : "simple" alternating current for the usual alternating currents in which there is practically but a single phase ; "di-phase" alternating currents for two alternating currents whose phases differ in time by 90 or 270 deg. ; "tri-phase" alternating currents for three alternating currents whose phases differ in time by 60 or 120 deg. ; "poly-phase" alternating currents for such as have more than three phases.

For expressions decribing phenomena of alternating currents and electro-magnetic waves, your committee solicits suggestions.

UNIVERSAL USE.—8. *Recommending the more universal use :—*

Of the term "voltage" as synonymous with "difference of electrical potential" or P.D. in place of the terms "potential," "tension," or "pressure," the use of which in this sense it is recommended to abandon.

Of the term "transformer" instead of "converter" ;

Of the term "dynamotor" for a continuous current transformer ;

Of the term "continuous current" instead of "direct current" ;

Of the term "kilowatt" instead of "horse-power" ;

Of the metric system of weights and measures, and suggesting means by which its introduction will be facilitated.

PROGRAMME.

Regarding the programme for carrying out this work in the most satisfactory manner to all parties, and with the least loss of time, your Committee's recommendations and suggestions are as follows :—

Preparatory Discussions.

It cannot be too strongly urged that an International Congress is the place to close, but not to open a discussion on questions about which international agreement is to be had ; it is therefore urgently recommended that action be taken at once to open the discussion of such matters now, in order that expressions of opinions, and, if possible, agreements, may be arrived at prior to the meeting of the Congress. To this end your committee recommends that the suggestions embodied in this report, or as many of them as you may see fit to designate, be printed and sent to all the leading electrical and physical societies and journals in this country and abroad, with a request that they aid this work by making them public, by freely discussing them, and by sending copies of such discussions and any further suggestions to the General Congress Committee of this Institute, care of the Secretary, 12, West Thirty-First Street, New York City That a sub-committee of the Institute prepare from time to time a classified summary of such discussions to be sent to the leading electric and physical journals for publication here and abroad, and that it present a final summary of this international discussion at the Congress. This discussion ought to be closed by July 1st, 1893.

It is recommended also that this Institute invite other societies to co-operate with it by appointing special committees to discuss and report to their respective societies on these international questions and to publish their conclusions in the electrical journals of their country.

It has been suggested that various committees be appointed to prepare reports on the international questions on which agreement is desired, and to submit these at the meeting of the Congress. Your committee, however, believes that to postpone the discussion until the Congress is in session would lead to no satisfactory results, as was shown at the last Congress of 1891, in Frankfort. It therefore urges

that the discussion take place through the medium of the journals *prior* to the meeting of the Congress, and that the only report submitted to the Congress be a summary of such discussions.

Meetings.

Regarding the meetings of the Congress, your committee recommends that, as in the Paris Congress of 1889, the meetings be divided into (*a*) *General Meetings*, one at the opening and one at the closing of the Congress, which are to be devoted to the consideration of general questions and those on which agreements are desired, and to the reading of papers of a general character; (*b*) *Sectional Meetings* for the reading of all other papers. The following division into sections is recommended:

1. Electro-physics, units, measurements, and all electrical matters of a purely scientific nature.
2. Dynamos, motors, transformers, &c.
3. Systems, central stations, installations, lamps, &c.
4. Electric telegraphy, telephony, and signalling.
5. Electric railways.
6. Electro-chemistry, batteries, electro-metallurgy.
7. Electro-physiology and electro-therapeutics.
8. Legal questions.

Papers.

It is suggested that specific invitations be extended by the Congress Auxiliary to prominent electrical engineers and physicists to prepare papers on specified subjects to be read and discussed at the congress meetings. Also, that a general invitation be extended for other papers, which are to be submitted not later than July 15th, 1893, to a committee on papers appointed by the chairman of the Congress Auxiliary; that this committee shall examine and accept or return the latter, and at its discretion shall print any or all of those accepted as well as those solicited, in form for circulation at least one week prior to the meeting at which they are to be read; that the papers shall be read in full, in abstract or by title, as that committee shall direct.

The following subjects of papers are offered as a suggestion to the Congress Auxiliary merely as a basis and not as a complete list:

The criterion of sensitiveness of galvanometers; or on the theory of their construction.
The working of National or Municipal Laboratories for testing meters and instruments.
The practical results and economy of the employment of accumulators in central station systems of supply.
On the relation between weight of copper and iron in dynamos and their output.
Nomenclature and notation of magnetic circuit; or on standard and units of magnetism.
Magnetism.
On the economic use of transformers under various conditions of supply.
Electricity meters from an European standpoint.
Electricity meters from a British standpoint.
Electricity meters from an American standpoint.
Choice of materials for standard of electrical resistance.
Nomenclature of phenomena of electro-magnetic waves.
Standards for electrical measurement.
Alternating current transformers from an American standpoint.
High frequency and high potential phenomena.
Dynamo construction.

Your committee suggests that papers should be solicited by the General Congress Committee of this Institute on the work of the early electricians of this and foreign countries considered from a modern standpoint, and their importance in the development of the science of electricity, including descriptions and illustrations of models and apparatus used.

Transactions.

Your committee suggests that the proper authorities be requested to have a stenographic report made of the proceedings and discussions at all the meetings of the Electrical Congress, and that this report, including such of the papers and discussions as a committee appointed for the purpose shall direct, shall be printed and published in book form; that each member of the Congress be entitled to one copy of this report on the payment of $1, and non-members on the payment of $5.

Membership.

It is suggested that the membership of the Congress be divided into delegated members and members; that the dues for each shall be $5; that only delegated members and members be admitted to the meetings, and be permitted to take part in the discussions; that anyone shall be entitled to become a member; that delegated members shall be appointed by governments, physical and electrical societies, and shall be approved by an international committee whose decision shall be final; that questions on which international agreement is desired be decided by the delegated members, whose decisions shall be submitted to the whole Congress for approval or rejection in part or in whole, but not for alteration.

It is recommended that the United States Government be requested to extend a formal invitation to foreign governments and societies to send delegates to this congress.

Acknowledgments.

In the present report, your committee has embodied recommendations from the reports of the Institute's Committee on Matthiessen's Standard, and on Magnetic Units, from the recent reports of the British Board of Trade Committee, and from the suggestions of Dr. Silvanus P. Thompson to Dr. Elisha Gray, in reference to the congress.

Respectfully submitted,

(Signed) CARL HERING, *Chairman*,
WM. A. ANTHONY,
A. E. KENNELLY.

New York, *December 28th*, 1892.

By a resolution adopted at the meeting of the General Congress Committee of the American Institute of Electrical Engineers, December 28th, the following proposed subjects, suggested by a Sub-Committee of the British Royal Commission for the Chicago Exhibition, were ordered to be published with this report:—

Subjects on some of which it is proposed that short and suggestive special papers might be read by specially selected members.

Comparison between procedure in different countries.
Methods of avoiding electrical interference and risks to person and property.
Units of magnetic quantities and mode of embodying them in concrete standards.
The adoption of the name "henry" for the unit of self and mutual induction.
Adoption of the "kilowatt" instead of the "horse-power" as the unit of power.
International nomenclature for describing phenomena of alternate currents and of electro-magnetic waves.
National and municipal testing laboratories.
Materials for standards of electric resistance.
Points of difference of the electrical vocabulary used in different countries.
The direct conversion of the energy of fuel into electric energy.
Comparison of the various methods employed for the electric transmission of power.
The cost of insulation in relation to high pressure for the electric transmission of power.
Comparison of the economies of the various systems of electric distribution.
Alternate current motors.
The behaviour of transformers when supplying power to alternate current motors.
The construction of condensers for alternate current purposes.
The measurement of power in polyphase currents.
Direct coupled and non-direct coupled dynamos.
The use of equalising dynamos in a three and a five-wire system.
The use of accumulators in central stations.
The proportions between output of dynamos and the weight of copper and iron employed in their construction.
Electric traction.
Application of electric power in mining.
The adoption of a uniform method of distinguishing positive and negative mains.
Electric Supply meters—American, British, Continental.
Criterion of sensibility of galvanometers.
Commercial instruments for measurement of electric quantities.
The relation between the voltage of the arc and the quality and composition of the carbons.
The ageing of glow lamps.
The electric working of metals.
The use of electric and magnetic tests for ascertaining the mechanical properties of metals and alloys.
The best material and mode of erection of lightning conductors in the light of recent researches in electric discharges.
The prospecting for iron by magnetic surveys.
International telegraphy.
Fast-speed and long-distance telegraphy.
The use of batteries or other generators for telegraphy.
Telegraphic lines—land and sea.

Harmonic telegraphy.
Writing telegraphs.
Long-distance telephony.
The possibility of providing telephonic communication without wires.
Application of electric signalling to the working of railways (alarms, time, &c.), and to naval and military purposes.
Magnetic separators.
The use of electricity in engraving and in art reproductions.

THERMAL RADIATION IN ABSOLUTE MEASURE.*

BY J. T. BOTTOMLEY, M.A., D.Sc., F.R.S.

THIS paper contains an account of an experimental investigation by the author in continuation of researches on the same subject which have been already published ("Roy. Soc. Proc," 1884, and "Phil. Trans.," 1887). In the earlier experiments metallic wires heated by an electric current were used. The loss of heat from a heated body, however, depends to some extent on the form and dimensions of the body, and it seemed important to experiment on the loss of heat from bodies differing in form from the wires already used, and larger in dimensions. Accordingly, two copper globes used by Mr. D. Macfarlane in 1872 ("Roy. Soc. Proc.," 1872, p. 93), were employed for a new series of experiments.

After preliminary experiments (using the same enclosure which Macfarlane employed, and with the surfaces of Macfarlane's globes prepared in four different ways) new apparatus was constructed; the object being to experiment both with full air pressure and with different amounts of exhaustion of the air, and Macfarlane's enclosure being unsuitable for this purpose.

In the arrangement adopted, the heated globes were hung at the centre of a hollow metallic sphere, which was connected with the Sprengel pump and surrounded with cold water, and were allowed to cool. The temperature of the cooling globe was read off at equal intervals of time by means of a thermo-electric junction; and from these readings the absolute loss of heat per unit of cooling surface, per unit difference of temperatures of surface and surroundings, per unit of time, is calculated.

The details of the apparatus and method of experimenting are given in the paper. It is enough to say here that the globes were used with their surfaces in two different conditions:—(1) Thinly coated with lamp-black, and (2) silvered and brightly polished; and in both conditions the absolute loss of heat, both in air and in vacuum, more or less complete, was determined. Some tables and curves attached to the paper give the details of the results.

To quote one or two examples:—With the sooted surface a total loss of heat by convection and radiation of $3{\cdot}42 \times 10^{-4}$ C.G.S. units per square centimetre, per second, per 1° C. of difference of temperatures of globe and surroundings, was observed with a difference of temperatures of 100° C., and with the surroundings at about 14° C. Under similar circumstances the radiation in vacuum of $\frac{1}{2}$ M (half-a-millionth of atmospheric pressure of non-collapsible gas) was about $1{\cdot}40 \times 10^{-4}$.

Taking a silvered and brightly-polished surface under the same circumstances, the loss in full air was $2{\cdot}30 \times 10^{-4}$ C.G.S.; and with the highest vacuum and brightest polish obtained, it was reduced $1{\cdot}80 \times 10^{-5}$ with in this case a difference of temperature of 180° C. The loss with 100° C. difference would be considerably less, but is not known experimentally at present.

The author returns thanks to Mr. James H. Gray, M.A., B.Sc., for excellent assistance given; and expresses himself most deeply indebted, both for assistance in experimenting and calculating of the results, and for most valuable and ingenious aid of various kinds during the course of this work, to his friend Mr. A. Tanakadate, now professor in Tokio, Japan.

ON THE MEASUREMENT OF THE MAGNETIC PROPERTIES OF IRON.†

BY THOMAS GRAY, B.Sc., F.R.S.E. Communicated by LORD KELVIN, P.R.S.

(*Abstract.*)

THIS paper gives the method of experiment and results obtained in some investigations on the time-rate of rise of current in a circuit having large electro-magnetic inertia. The experiments were made on a circuit containing the coils of a large electro-magnet having laminated cores and pole pieces. The mean length of the iron circuit was about 250 cm., and its cross section 320 sq. cm. The magnetising coil had 3,840 turns, when all joined in series, and a resistance of 10·4 ohms. The coils were so arranged that they could be joined in a variety of ways so as to vary the resistance, inductive coefficient, &c., and also to allow the magnet to be used either as an open or closed circuit transformer.

The electromotive force used in the experiments was obtained from a storage battery, and the method of experiment was to trace the curve, giving the relation of current to time, on a chronograph sheet.

One set of experiments shows the effect of varying the impressed E.M.F. on the time required for the current to attain any given percentage of its maximum strength. The results show that for any particular percentage there is always a particular E.M.F. which takes maximum time. Thus for the circuit under consideration, and with successive repetitions of the current in the same direction, it takes longer time for the current produced by an impressed E.M.F. of 4 volts to reach 95 per cent. of its maximum, than it takes for the current produced by either 3 or 5 volts to reach 95 per cent. of their maximum. The results show also that, within considerable limits, the time required for the current to become uniform is, on the whole, nearly inversely proportional to the impressed E.M.F., and that for moderate values of the E.M.F. the time may be very great; when the E.M.F. was 2 volts, and the current sent in such a direction as to reverse the magnetism left in the magnet by a previous current of the same strength, the time required for the current to establish itself was over three minutes. The difference of time required for repetition and for reversal of previous magnetisation was also very marked when the iron circuit was closed. The results show that great errors may arise by the use of ballistic methods of experiment, especially when weak currents are used, and that for testing resistances of circuits containing electro-magnets, a saving of time may be obtained by using a battery of considerable E.M.F.

Another set of experiments gives the effect of successive reversals of the impressed E.M.F. at sufficient intervals apart to allow the magnetisation to be established in each direction before reversal began. In this set also the effect of cutting out the battery and leaving the magnet circuit closed is illustrated, showing that several minutes may be required for the magnet to lose its magnetism by dissipation of energy in the magnetising coil. The effect on these cycles of leaving an air space in the iron circuit is also illustrated. It is shown that a comparatively small air space nearly eliminates the residual magnetism, and diminishes considerably the rate of variation of the co-efficient of induction and the dissipation of energy in the magnet.

Several cycles are shown for the magnet used as a transformer with different loads on the secondary. The results give evidence that there is less energy dissipated in the iron the greater the load on the secondary of the transformer.

Some experiments are also quoted which go to show that the dissipation of energy due to magnetic retentiveness (magnetic hysteresis) is simply proportional to the total induction produced when the measurements are made by kinetic methods. Reference is made to the recent experiments of Alexander Siemens and others, which seem to confirm this view.

* Abstract of paper read before the Royal Society.
† Royal Society. Received May 3rd, 1892.

LEGAL.

NATIONAL TELEPHONE COMPANY *v.* GRAFF-BAKER.
High Court of Justice.—Chancery Division.
(Before Mr. Justice Kekewich.)

(*Continued from page* 95.)

FOURTH DAY (*continued*).—JANUARY 12th, 1893.

Mr. ROBERT WINTHROP BLACKWELL, at one time general manager of the Bentley-Knight Electric Railway in New York, but now in business in London as an electrical engineer, gave evidence as to a short trial line, 200 yards in length, in Cleveland, Ohio, on the series system. From the result of the trial line it was supposed that the system would be operative, but when they got beyond the short trial line they found it was impossible to use it commercially, and discarded it. His experience taught him that the only practical commercial system was the single overhead conductor system. The Thomson-Houston system was mainly the elaboration of those systems which had gone before, and the Thomson-Houston management combined in themselves probably the best talent in the United States; but so far as originating a new method was concerned, there was no such thing as a Thomson-Houston system. He had, himself, laid several short lines with double conductors, but they had been all discarded in favour of the single conductor and trolley. With underground conductors he had found it an extreme difficulty to keep the conduits clean and properly drained out; slush, salt, snow, and other matter frequently bridging over from the conductors to their metallic supports. The operation of switches on a conduit line was most difficult, and required special appliances, and the switches were constantly susceptible of getting out of order. The width of the slot varied in America from $\frac{3}{4}$-inch to $\frac{1}{4}$-inch, and questions several times arose through vehicles getting caught in the slot. Most of the difficulties occurring with double underground conductors applied with even greater force in the case of a double overhead system, which, he thought, would be hopeless when complexities arose in the way of switches, and turn-outs and cross-overs. When working with the double overhead system in America, he had frequently had complaints from telephone companies as to interference.

Cross-examined by Sir RICHARD WEBSTER: He was not connected

with Thomson-Houston, who was an antagonist of his, and practically drove him to the wall in 1890. If the question of expense were ignored, there was absolutely no difficulty whatever in establishing the double overhead or the conduit system.

Mr. CLARENCE FRANK LEIGHTON, a solicitor in the case, gave evidence of a visit to Stockholm to investigate the telephonic systems there. The Almanar Company, with from 8,000 to 9,000 subscribers, were changing from earth returns to metallic returns, and the latter were worked in conjunction with the former. He was put in communication with some of the subscribers, and conversed with them. The Government had an exchange at Stockholm, with about 1,200 subscribers, which was entirely carried out with metallic returns. The subscribers to the one were able to converse with the subscribers to the other exchange. In the case of the company, where one subscriber's wire went to earth and the other had a metallic return, the two were put into communication without the intervention of a transformer. The charge was 80 kroners a year, or about £4 12s., whether metallic circuit or otherwise.

Mr. MOULTON said there was no dispute whatever as to the working of the metallic return in conjunction with the earth return. But there was a dispute as to whether it would work where there were tramway disturbances.

The Court then adjourned for the day.

FIFTH DAY.—JANUARY 13TH.

Mr. BOUSFIELD announced that Prof. Forbes was ill and would not be called.

Mr. JOHN SERJEANT WISE, an American lawyer, who had made a special study of the question of disturbances between telephones and tramways, said the question had been tried 15 or 20 times in the United States in actions of this sort, and he had been engaged in all those actions. He gave particulars of cases where the difficulty had been overcome by the telephone company constructing a return, consisting of a large copper wire of low resistance, and of sufficient capacity to conduct the return on various disturbed telephone lines. Instead of being connected to earth, the subscribers' lines were connected to the common return, and this was found sufficient. He also gave evidence as to the single trolley system of tramways having superseded almost every other system which had been tried in the States.

Prof. SILVANUS PHILLIPS THOMPSON, F.R.S., said he was at one time a subscriber to the telephone exchange in London, but the disturbances were so great that he ceased to be a subscriber. He could never make himself heard and could never hear from the places with which he wanted to communicate—Kensington and Westminster. He had talked more recently over the London exchange, and the communication was certainly better than it used to be, but he could not say whether the lines over which he had talked were purely on earth returns, or whether they went through metallic circuits. A system depending on earth returns was liable to disturbance from telegraphs, electric light, other telephones, and all kinds of stray disturbances which might arise from systems of electric distribution, for if the wires went to earth, single wires, going to earth at various points, would be subjected to interferences not only by conduction through the earth, coming by the earth return and going back through the wires, but also by induction acting on any neighbouring wires. He had long held that, having regard to the numberless applications of electricity at the present day for general purposes, the only rational way to lay out any telephone system, in any town or city, not to speak of scattered districts, was to give every subscriber a metallic circuit. The chief causes of disturbances as between a tram conductor and parallel telephone lines were, actual conduction through the earth, or leakage; electromagnetic disturbance from wire to wire through the air; and electrostatic effects, charging of wires from one another through the air. Of those three, the last was practically non-existent on short lines, and where it did exist might be rendered negligible by the use of a condenser. At Leeds, he believed, looping back the lines by a trunk wire earthed near the exchange would do everything that was wanted, without condensers at all. A transformer was a little induction coil a couple of inches long, and two wires wound round it; its cost would be about 1s. or 1s. 6d.

Cross-examined by Sir RICHARD WEBSTER: He had ceased to be a subscriber to the London exchange for four or five years. When he had wanted to speak to Kensington, again and again his only way of obtaining communication was to get the operator at the exchange to repeat what he had said to Kensington; and sometimes he could not even get through in that way. Doubling back part of the circuit, past the source of the disturbance, and then connecting with the earth return, would eliminate disturbances arising from electromagnetic induction. He had never practically set to work at any telephone exchange to try and get rid of disturbances by partially doubling back, but he had tried it on experimental circuits.

With regard to transformers, is there not one practical difficulty, that you have to put in two transformers to make it useful to you—one to each subscriber?—Yes, one to each subscriber.

Is there not a very considerable difficulty in ringing up?—It depends upon the manner of your ringer and of the arrangements. If the ringer has been built on old-fashioned lines, to work on a single line without any transformers, it might be difficult.

Is it not the fact that, speaking of ordinary telephonic work, there is a difficulty in transforming if you have to ring through?—I think not, if you have a modern instrument to ring through. There was a practical difficulty if old-fashioned instruments were used.

Mr. OSCAR TERRY CROSBY, of Boston, U.S.A., Vice-president of the American Institute of Electrical Engineers, affirmed that he had been an officer in the Engineer Corps of the United States Army, for two years was general superintendent of the Sprague electric railway, and was now general manager of the railway department and the power transmission department of the General Electric Company. There were now something like 6,000 individual cars in the States, operated electrically by 600, 700, or 800 different companies. He had paid special attention to the double trolley system, when there were a few examples for it; there were four or five two and a-half years ago, but they were now no longer to be found, having been supplanted by the single trolley system. The double trolley system was not now used, because it was found that it was burdensome from an æsthetic point of view; that was, perhaps, the least consideration with them, but it occurred to him first. Then it was also very much more difficult to instal originally, on account of the greater number of parts to be used; and, worst of all, it was found exceedingly unreliable in its daily operation, although in each instance the line was worked on a very small scale as compared with the scale which the business had now reached. They were in comparatively small towns, and the complexities as to crossings were very few as compared with what must be found in large cities. Yet, with those simple conditions, the operation was found to be very burdensome; it was necessary to put up such considerable surfaces in the holding devices and the insulating devices, that snow and sleet found a very considerable lodgment on them, very much more than could be found on the devices used for the single system, and it was the constant interruptions, due to this cause, which finally broke the thing down. He was familiar with the telephonic systems in the United States in a general way. In the early stage of the telephones earth returns were practically universal, but there was already a considerable accomplishment of change to the metallic circuit.

Cross-examined by Sir RICHARD WEBSTER: The single trolley system was cheaper to make, cheaper to instal, and cheaper to work.

Mr. JOHN CHARLES CHALMERS, an electrical engineer, of Glasgow, stated that, having read in the newspapers Lord Kelvin's evidence with regard to the electric light in a train in a tunnel near Glasgow, and the telephone disturbance caused by it, he had communicated with the defendants. He had had to do with four telephones affected by that particular disturbance, and tried various methods of remedying it, but without success until the wire was doubled back for a considerable distance and earthed at some distance from the line of electric disturbance. This was almost a perfect cure, and the noise from the railway was no more heard.

Mr. CLARENCE LEIGHTON having been recalled to put in a plan representing the junction of the tramway at Roundhay Road and Harehills Road,

The SOLICITOR-GENERAL said that concluded the defendants' case.

Dr. JOHN HOPKINSON was recalled by the plaintiffs and examined by Mr. MOULTON with reference to the model put in by Mr. Sellon. He said the distance between the two conductors in the model was greater in proportion to the distance between the rails than was the case at Buda Pesth—probably three times as great. The effect of that upon the objection to which Mr. Sellon referred would be to increase the length of the break, not in the same proportion merely, but in proportion to the square root.

Cross-examined by Mr. BOUSFIELD. He could not controvert the statement as to the length of the break; all he spoke to was the distance between the two conductors in relation to the distance between the two rails. There was no trouble with switches at Buda Pesth, because there were none.

Mr. JUSTICE KEKEWICH said: Broadly speaking, there were three questions before the Court; first, whether the telephonic system of the plaintiffs was at all, to any material extent, disturbed by the operations of the defendants; secondly, whether the plaintiffs could themselves, by adopting a system different from that which was really adopted by them, obviate that disturbance, or, at any rate reduce it to a negligible quantity; and thirdly, whether, assuming that there was a disturbance, and that that disturbance would continue if the defendants continued their operations as at present, they were relieved from the ordinary obligation of British subjects, of so conducting their operations as not to interfere with their neighbours. As regards the first question, he was satisfied from the evidence, and particularly from Mr. Macrory's report, that there was a material disturbance. As regarded the second question, he had yet to be persuaded that it arose at all. The third question was a momentous one, and to his mind had been all along, and still was, the only real question in the case, namely, whether the defendants were entitled to do that which they were doing, admitting, for the purposes of argument, that it was a serious interference with the plaintiff company's works. That depended upon a variety of authorities, principles of law, and, of course, upon the facts of the case. That was eminently defence, and, being so, it would be better to leave the defendants to make out their own case.

Sir RICHARD WEBSTER said he should be quite satisfied to defer any comments upon the evidence until his reply.

The SOLICITOR-GENERAL then addressed the Court for the defence upon the third question which his Lordship had stated. The case was one of nuisance, and did not depend upon statute law at all; the plaintiffs came forward to claim a common law right. A nuisance was an interference with an easement, or an interference with real property, but involved the possession of that property. The mention of the dates must satisfy his Lordship that there could be no easement in the case of the telephone. Telephonic communication was not known in England 20 years ago, therefore there could be nothing in the nature of immemorial usage, nothing in the nature of an enjoyment which would, by prescription, give rights against any person at all. The whole of the Solicitor-General's address, which occupied the remainder of the day, was directed to this point, and a number of cases illustrating his contention were cited.

SIXTH DAY.—JANUARY 17TH.

The SOLICITOR-GENERAL being unable to continue his address, Mr. BOUSFIELD took up the argument, and cited the American case of

the Cumberland Telephone and Telegraph Company *v.* The United Electric Railway, the head-note to which stated that: "In the present state of electrical science a telephone company cannot maintain a Bill for an injunction against the operation of an electric railway to prevent damages incidentally sustained by the escape of electricity from its rails." Having quoted from the judgment in this and analogous cases, Mr. Bousfield referred to the question of statutory powers, upon which Sir Richard Webster had cited several cases. The defendants' case rested upon the well-known case of Vaughan *v.* the Taff Vale Railway Company.

Mr. JUSTICE KEKEWICH said that case, of course, deserved great attention and respect; but the real question was, Was it within the Metropolitan Asylums Board *v.* Hill, or the London Brighton and South Coast Railway Company *v.* Truman, two cases in the House of Lords, one summing up one class of cases, the other summing up another class of cases.

Mr. BOUSFIELD said those two cases practically did sum up the law upon the point. In the Metropolitan Asylums Board *v.* Hill, it was a question of statute. There was no authority; there was only a general power to erect hospitals, the selection of which was a thing that obviously must be done by the authorities in such a way as to incommode the public as little as possible. Here they had a special authority given to use electric power on the trams. This was almost identical with the case of Vaughan *v.* The Taff Vale Railway Company. which was a case of dangerous employment of a dangerous article, a locomotive, and it was upon that ground that the statute had expressly authorised the use of a dangerous article, and that the dangers of the article were contemplated in authorising its use. It was upon that ground that the result, namely, the sparks setting fire to some of the property, was one contemplated, and one against which the defendants were protected. That case came extremely close to this. Assuming, of course, that the danger from an electric railway, in reference to this case, was a danger simply of disturbing somebody else's wires, that was a danger which the use of electricity involved. His submission was that the use of the dangerous apparatus was authorised, and that the particular danger or apparatus was directly contemplated by the statute that authorised it. There was a recognition in the authorising section of the Act of the danger which might arise from the use of electric power. The Board of Trade were, in their discretion, to make regulations for the use of it, so as to secure to the public all reasonable protection against danger. His Lordship knew that in this case the Board of Trade had made regulations, and had given its consent to the particular system here adopted. In the absence of negligence in their use of the powers, he held they were not responsible. In the London, Brighton and South Coast Railway *v.* Truman, it was held that there had been a certain amount of negligence in the use of their statutory powers, and on that the defendants were held to be liable. The plaintiffs in this case were carrying on a business which must necessarily involve, in the way in which they did it, disturbances from any stray currents of electricity which happened to be going about. In the very nature of things, as a part of their business, they ought to protect themselves against that. Other people in other countries had recognised this, and he contended that they had no legal right whatever to claim immunity from disturbances against which they could, if they pleased, protect themselves. It was a question, of course, as to what really were the ordinary means of protecting themselves. The plaintiffs happened to be the only people in this country engaged in this business, and where there was only one person engaged in the business, they could not take the practice of that one person to settle what was usual. Yet, they might look to the case of the New Telephone Company, when that was in existence, and of the Post Office, both of which acknowledged that the liability to disturbance was an ordinary incident of their business, against which they ought to protect themselves. All over the world, practically, other people were doing the same; in America, at Paris, and at Stockholm, they were fast transforming their exchanges. The plaintiffs apparently still stuck, either from motives of economy, or that the list of dividends might be kept up to its high water mark, to the old "cheap and nasty" earth return method. He submitted that the law would not give them that protection which they themselves could very readily supply.

Sir RICHARD WEBSTER, in replying, said the Solicitor-General had spoken of the plaintiffs and the defendants as though they were each of them drawing upon electricity from a common reservoir in the earth. The facts in evidence showed that no such analogy existed. His learned friend had been anxious to bring the case into that class of cases which were best illustrated by underground water. Chasemore *v.* Richards showed that, though the brewer's well was the only source of water whereby he could make his beer, the adjoining proprietor might sink a deeper well and tap him altogether, and no action of any kind would lie. But that was not what was taking place in this case. The defendants were not drawing from the reservoir of the earth—putting down a pipe and getting up natural water. They used steam engines and dynamos, and generated vast currents of electricity, which did not exist in the natural and uninterrupted condition of the earth. The defendants were establishing a non-natural condition of things, that was to say, they were for their own purposes, and lawfully, if they did no harm to anybody else, producing violent currents of electricity. In answer to the suggestion that the defendants were only drawing from a natural reservoir, and were doing nothing that could be complained of, he said, with deference, that the only test was whether or not, having created this unnatural condition of things to a great extent, as the plaintiffs had created it to a minimum extent, a defendant who allowed the electricity to escape from his own property and to do damage to his neighbours, was liable to action. The moment they swept away the Solicitor-General's analogy of the pumping up from a common reservoir, the case was brought into line with a well-defined class of cases. The defendants created upon their property an artificial state of things, the effect of which was to interfere with the plaintiffs' property and the plaintiffs' right. He could not imagine anything more dangerous than the suggestion that the law did not favour the view that at least a person should use his own property for his own trade in a way that did not interfere with other trades. A somewhat curious and far-fetched argument had been used, that they must have contemplated electricity which would do harm to neighbours, because there was a clause which especially protected the telegraphs, which were the property of the Postmaster-General. Anybody must have very little experience of the passing of private Bills through committees to use any such argument in a court of justice. What happened was this: the Government, through the competent authorities, opposed a Bill, and only allowed it to go through upon certain terms. The point of it was, that they had to give notice to the Postmaster-General to specify the nature of the work, and a number of protective clauses were inserted which no private individual had a right to claim. Private individuals were left to assert their rights in the Courts in the way they were doing. The proposition that they must alter their system so as to permit the defendant to let loose their electricity with impunity, involved a contradiction in terms. It had never been suggested that, given a defendant who, as in Fletcher *v.* Rylands, had brought about an artificial state of things, he was to be allowed to put on another person the burden of protecting himself against that which was an unlawful act.

After the luncheon interval, the SOLICITOR-GENERAL addressed the Court at his LORDSHIP'S request, with special reference to the case of The London, Brighton and South Coast Railway Company *v.* Truman, and Sir RICHARD WEBSTER having concluded his reply,

Mr. JUSTICE KEKEWICH said he must consider the case, and would do so as soon as other duties permitted.

DONOVAN *v.* THE LAING, WHARTON, AND DOWN CONSTRUCTION SYNDICATE.

IN this case, tried before Mr. Baron Pollock on the 19th inst., the defendants applied on Monday last to the Court of Appeal, consisting of the Master of the Rolls and Lords Justices Lindley and Lopes, to order the plaintiff to find security for the costs of the appeal he had entered in the matter.

Mr. RAWLINSON, who appeared for the applicants, said the action was one for personal injuries, and a verdict was found for the plaintiff for £500 damages, subject, however, to a point of law raised by the defendants, the plaintiff was not a servant of theirs. On this the learned Baron entered judgment for the defendants, and plaintiff had given notice of appeal. He was a labouring man absolutely without means, and defendants believed that the action was really undertaken for him by a Trades Union, upon whom the defendants could not come for the costs, in case the Court should support the learned Baron's decision.

Mr. LYNDEN BELL, for the plaintiff, said that he was instructed the statement as to a Trades Union being the real plaintiff, which had been made in an affidavit only handed to plaintiff that morning, was not the fact, and that, if their Lordships desired, it could be so stated on affidavit.

Mr. RAWLINSON, in the course of further argument, said there was no dispute that the man was seriously injured, and that it was caused by neglect; but the defendants said he was employed not by them, but by somebody else.

Lord JUSTICE LOPES: And was that found against you?

Mr. RAWLINSON said: No, it was never left to the jury, and added that it had been held a man's poverty should, in certain cases, be used to prevent his involving the other side in law costs; but here there was somebody behind him whom the defendants could not reach if the ultimate decision should be in their favour.

The MASTER OF THE ROLLS said he believed the Court had never yet allowed the "man behind" to influence their decision; and he thought in the present instance they should decline to make the order asked for.

The LORDS JUSTICES assenting, the application was refused, no order being made as to the costs of making it.

SOME MECHANICAL AND ELECTRICAL ANALOGIES.

BY DR. F. BEDELL AND DR. A. C. CREHORE.

No phenomena are so readily comprehended as those which may be compared directly with facts that are familiar, and no reasoning is so quickly grasped as reasoning "by analogy." The analogies between certain mechanical and electrical relations are so striking that when either relations are understood the others follow, and from the laws of mechanics we can readily write those of electricity. The process is a reversible one and the electrician can, with equal ease, step over into the realms of dynamics. To enable one to reason accurately in this manner and to reach definite results with absolute certainty, it is necessary to give with exactness the fundamental relations of mechanics and electricity. The

following tables are, therefore, given showing the analogies between linear motion, motion of rotation and the electric current. Starting a current of electricity in a circuit is analogous to imparting motion to a body and requires an impressed force. This force must overcome the resistance (electrical resistance corresponding to that of friction) and the inertia of the mass or current.

In the case of the electric current this inertia is called "self-induction." A revolving fly-wheel may well represent the flow of electricity, its velocity corresponding to the current, its moment of inertia to the co-efficient of self-induction and the friction to ohmic resistances.

TABLE I.—LINEAR MOTION.

NOTATION.

1. Time $= t$.
2. Distance $= s$.
3. Linear velocity $= v = \frac{ds}{dt}$. $\quad ds = v\,dt$.
4. Linear acceleration $= a = \frac{dv}{dt} = \frac{d^2 s}{dt^2}$.
5. Mass $= \mathrm{M}$.
6. Momentum $= \mathrm{M}\,v$.

FRICTIONAL RESISTANCE.

7. Frictional resistance $= \mathrm{R}$.
8. Force to overcome resistance $= \mathrm{F_R} = \mathrm{R}\,v$.
9. Energy expended in overcoming resistance in the time dt, $= d\,\mathrm{W_R} = \mathrm{F_R}\,ds = \mathrm{R}\,v^2\,dt$.

INERTIA.

10. Force to overcome inertia $= \mathrm{F^1} = \mathrm{M}\,a = \mathrm{M}\frac{dv}{dt}$.
11. $\left\{\begin{matrix}\text{Kinetic energy acquired}\\ \text{in the time } dt,\end{matrix}\right\} = d\,\mathrm{W^1} = \mathrm{F^1}\,ds = \mathrm{M}\,v\frac{dv}{dt}\,dt$.
12. Kinetic energy $= \mathrm{W^1} = \int_0^v \mathrm{M}\,v\frac{dv}{dt}\,dt = \frac{1}{2}\,\mathrm{M}\,v^2$.

INERTIA PLUS RESISTANCE.

13. Total force applied $= \mathrm{F} = \mathrm{F_R} + \mathrm{F^1} = \mathrm{R}\,v + \mathrm{M}\frac{dv}{dt}$.
14. Total energy supplied in the time $dt = d\,\mathrm{W} = d\,\mathrm{W_R} + d\,\mathrm{W^1}$; or, $\mathrm{F}\,ds = \mathrm{F_R}\,ds + \mathrm{F^1}\,ds$; or, $\mathrm{F}\,v\,dt = \mathrm{R}\,v^2\,dt + \mathrm{M}\,v\frac{dv}{dt}\,dt$.

TABLE II.—ROTARY MOTION.

NOTATION.

1. Time $= t$.
2. Angle $= \phi$.
3. Angular velocity $= \omega = \frac{d\phi}{dt}$. $\quad d\phi = \omega\,dt$.
4. Angular acceleration $= \alpha = \frac{d\omega}{dt} = \frac{d^2\phi}{dt^2}$.
5. Moment of inertia $= \mathrm{I}$.
6. Angular momentum $= \mathrm{I}\,\omega$.

FRICTIONAL RESISTANCE.

7. Frictional resistance $= \mathrm{R}$.
8. Torque to overcome resistance $= \mathrm{T_R} = \mathrm{R}\,\omega$.
9. $\left\{\begin{matrix}\text{Energy expended in overcoming}\\ \text{resistance in the time, } dt\end{matrix}\right\} = d\,\mathrm{W_R} = \mathrm{T_R}\,d\phi = \mathrm{R}\,\omega^2\,dt$.

INERTIA.

10. Torque to overcome inertia $= \mathrm{T^1} = \mathrm{I}\,\alpha = \mathrm{I}\frac{d\omega}{dt}$.
11. $\left\{\begin{matrix}\text{Kinetic energy acquired in}\\ \text{the time } dt\end{matrix}\right\} = d\,\mathrm{W^1} = \mathrm{T^1}\,d\phi = \mathrm{I}\,\omega\frac{d\omega}{dt}\,dt$.
12. Kinetic energy $= \mathrm{W^1} = \int_0^\omega \mathrm{I}\,\omega\frac{d\omega}{dt}\,dt = \frac{1}{2}\,\mathrm{I}\,\omega^2$.

INERTIA PLUS RESISTANCE.

13. Total torque applied $= \mathrm{T} = \mathrm{T_R} + \mathrm{T^1} = \mathrm{R}\,\omega + \mathrm{I}\frac{d\omega}{dt}$.
14. Total energy supplied in the time $dt = d\,\mathrm{W} = d\,\mathrm{W_R} + d\,\mathrm{W^1}$, or, $\mathrm{T}\,d\phi = \mathrm{T_R}\,d\phi + \mathrm{T^1}\,d\phi$; or, $\mathrm{T}\,\omega\,dt = \mathrm{R}\,\omega^2\,dt + \mathrm{I}\,\omega\frac{d\omega}{dt}\,dt$.

TABLE III.—ELECTRIC CURRENT.

NOTATION.

1. Time $= t$.
2. Quantity $= q$.
3. Current $= i = \frac{dq}{dt}$. $\quad dq = i\,dt$.
4. Current acceleration $= \beta = \frac{di}{dt}$.
5. Coefficient of self-induction $= \mathrm{L}$.
6. Electro-magnetic momentum $= \mathrm{L}\,i$.

OHMIC RESISTANCE.

7. Ohmic resistance $= \mathrm{R}$.
8. Electromotive force to overcome resistance $= e_\mathrm{R} = \mathrm{R}\,i$.
9. $\left\{\begin{matrix}\text{Energy expended in overcoming}\\ \text{resistance in the time } dt\end{matrix}\right\} = d\,\mathrm{W_R} = e_\mathrm{R}\,dq = \mathrm{R}\,i^2\,dt$.

SELF-INDUCTION.

10. $\left\{\begin{matrix}\text{Electromotive force to overcome}\\ \text{self-induction}\end{matrix}\right\} = e^1 = \mathrm{L}\,\beta = \mathrm{L}\frac{di}{dt}$.
11. $\left\{\begin{matrix}\text{Energy acquired by the mag-}\\ \text{netic field in the time } dt\end{matrix}\right\} = d\,\mathrm{W^1} = e^1\,dq = \mathrm{L}\,i\frac{di}{dt}\,dt$.
12. Energy of magnetic field $= \mathrm{W^1} = \int_0^i \mathrm{L}\,i\frac{di}{dt}\,dt = \frac{1}{2}\,\mathrm{L}\,i^2$.

RESISTANCE PLUS SELF-INDUCTION.

13. Total electromotive force applied $= e = e_\mathrm{R} + e^1 = \mathrm{R}\,i + \mathrm{L}\frac{di}{dt}$.
14. Total energy supplied in the time $dt = d\,\mathrm{W} = d\,\mathrm{W_R} + d\,\mathrm{W^1}$; or, $e\,dq = e_\mathrm{R}\,dq + e^1\,dq$; or, $e\,i\,dt = \mathrm{R}\,i^2\,dt + \mathrm{L}\,i\frac{di}{dt}\,dt$.

A study of the tables will make these analogies more clear. It is to be noted that the fly-wheel or moving mass, in slowing down gives back its kinetic energy and the wheel is carried on, after the impressed force is removed, until this is entirely consumed in overcoming friction. Similarly, when the current diminishes upon the removal of the impressed electromotive force, the energy stored in the magnetic field is restored to the circuit and the current keeps flowing until the energy is entirely used up in overcoming the ohmic resistance.

These analogies cannot be considered as rigorous proof. The truth of the relations here given for the electric current has been fully established and may be found in the introductory chapter to our work on alternating currents. Other striking analogies will suggest themselves, but space will not permit calling attention to any but the most fundamental ones given above.

COAST COMMUNICATION.

THE first report of the Royal Commission appointed to inquire what lighthouses and light-vessels it is desirable to connect with the telegraphic system of the United Kingdom by electrical communication, was issued last Wednesday. The report is signed by the Earl of Mount-Edgecumbe (chairman of the Commission), Mr. H. L. Mulholland, Sir Edward Birkbeck, Admiral Sir F. L. M'Clintock, K.C.B., Rear-Admiral Sir G. S. Nares, K.C.B., Mr. J. C. Lamb, C.M.G., Mr. J. A. Kempe, Mr. R. C. Munro-Ferguson, Mr. W. H. Preece, and Mr. Garnham Roper, secretary.

It will be recollected that the object of the Commissioners in considering what lighthouses and light-vessels it was desirable to connect with the telegraphic system of the United Kingdom "was the giving information of vessels in distress, or casualties at sea to places from which assistance could be sent, and of transmitting storm warnings." The Commission was issued on the 13th of June, and the first meeting was held on the 18th of that month. In August, the Commission made a tour of inspection of lighthouses and light-vessels in the United Kingdom, and met again in London in October, when further evidence was taken, and the first report prepared. This report was finally adopted on December 8th.

In their general remarks the Commissioners state that the need for electrical communication for the purposes referred to appears to be the greatest in the case of certain light-vessels marking outlying shoals beyond reliable range of the shore for sight or sound signalling. The crews of this vessel, consisting usually of about seven men, keep a regular look-out night and day, and can therefore be relied upon to give notice of vessels in distress, which is not the case with lighthouses, where there are only two or three keepers. For the present the Commissioners only recommend immediate action to be taken in five of the most urgent cases. They recommend one "pile-lighthouse" for immediate attention; and with regard to shore lighthouses, they recommend nineteen for immediate connection, as being among the most important, and at the same time involving but little cost. The

cases of lighthouses situated on islands or isolated rocks appeared to present the greatest difficulty, and three such lighthouses only are recommended for connection with a continuous cable.

The report proceeds to mention a number of light vessels and lighthouses which the commissioners consider should be attended to at once. They recommend that the Goodwin (North Sand Head), Kentish Knock, Shipwash, Hasborough, and Scarweather light vessels be immediately connected; and as it has been proved that there is no difficulty in employing the telephone on board light vessels, they recommend that system for them and for general use in lighthouses. Each of the light vessels mentioned occupies a position in a locality where casualties have been numerous, and where the passing trade is in some cases very large. The Goodwin, for instance, commands a good look-out over the trade route through the Straits of Dover and that portion of the Sands where the casualties are most numerous. In the 10 years preceding June, 1891, there were no less than 122 strandings reported. If provided with a telegraphic cable the lightship would probably have to be replaced by a more efficient vessel. The Kentish Knock light vessel affords a good central station amongst the off-lying light vessels at the Thames entrance, and in conjunction with the Gunfleet Lighthouse (which is recommended for immediate connection) commands a look-out with a visual range of seven miles over the intervening dangers. The passing trade is large, and casualties are numerous. She is well adapted to receive a telegraph cable. The Goodwin is 5½ nautical miles from the nearest land, and the Kentish Knock 18 miles.

The estimated cost of carrying out the electrical communications recommended by the Commission is as follows:—

Light Vessels.—Goodwin (North Sand Head), £1,325; Kentish Knock, £3,575; Shipwash, £2,100; Hasborough, £2,320; Scarweather, £2,145.

Pile Lighthouse.—Gunfleet, £1,535.

Shore Lighthouses.—Start Point, £125; Anvil Point, £85; Needles, £200; Orfordness, £85; Girdleness, £70; Moss Head, £110; Cantick (Orkney), £160; Mull of Cantyre, £50; Corsewall (Stranraer), £195; Mull of Galloway, £215; Douglas Head, £30; Point of Ayre, £70; Nash (both lighthouses), £160; Minehead (Dungarvan), £210; Hook Point (Waterford), £265; Bailey (Howth), £85.

Lighthouses on Islands or Isolated Rocks.—Caldy, £853; Lundy, £3,614; Tuskar, £1,722.

It is recommended that the Fastnet be connected by telephone (combined with Morse sounder), or by mirror galvanometer, at an estimated cost of £3,800.

"It is assumed," says the Report, "that the lighthouse authorities will provide the mooring chains, swivels, bow sheaves, deck leads for veering cable, and all fittings and appliances for securing the cable drums and windlasses between decks in the case of the light-vessels, and for any builder's work that may be requisite in the case of the lighthouses."

In conclusion the Commissioners express their intention of visiting other portions of the coast another season, and to take further evidence, especially as regards engineering questions relative to cable communication with rock lighthouses.

NOTES.

The Electrical Properties of Boron.—Mons. H. Moissan has recently been investigating the properties of pure amorphous boron, which he obtained by reducing boric anhydride by means of metallic magnesium. He finds that even when placed in the electric arc the substance cannot be fused. When treated, however, for a long time at a temperature of 1,500° Centigrade, it shows some signs of agglomeration. The electrical conductivity of this substance is small and its specific resistance $a = 801$ megohms. In its chemical relations it has been demonstrated that amorphous boron exhibits some remarkable analogies with carbon.

Electric Pyrometery.—In the original Siemens electric pyrometer the coil of platinum wire is wound on a clay cylinder and packed in an iron tube 5—8 feet long and 1—2 inches diameter. Upon examining one of these instruments, which had never been used to measure temperatures above 1,600 Fah., Mr. Callender found that its resistance had increased about 15 per cent., corresponding to an error of 100° Fah. in the temperature measurements. There is no doubt that the clay in some way affects the character of the platinum, hence an improvement has been introduced which consists in winding the coil upon sheets of mica, which at 1,200° Centigrade even has no action whatever upon the wire. The old iron tube is now done away with, a tube of glass or porcelain being substituted for it, whilst the platinum leads are fused instead of soldered to the wire in the coil. A further improvement is the Wheatstone bridge method of measuring the resistance of these electric pyrometers; in the original form the differential galvanometer method was resorted to. These improvements have certainly increased the accuracy and the facility with which the instruments may be used in practical work.

The Temperature of the Electric Arc.—According to M. Violle's researches, recently communicated to the French Academy of Sciences, the luminosity of the crater of the arc, says *Industries*, is sensibly constant. We may therefore hope that the standard of light proposed last year by Mr. Swinburne may be adopted and come into general use.

Thermo-Electric Phenomena between two Electrolytes.—In a paper communicated by Mons. Henri Bagard to the Paris Academy of Science on April 25th, 1892 (*vide Comptes Rendus*, cxiv., p. 980), experiments were described in which two electrolytes exhibited under certain conditions some interesting thermo-electric phenomena. The observations then recorded have been followed up by a further investigation of a more quantitative character, in which the thermo-electric force between two portions of the same electrolyte in different stages of dilution has been determined. A paper full of results and illustrated by curves was contributed by Mons. Bagard to the *Proceedings* of the Academy of Science on January 2nd. These results refer to five solutions of zinc sulphate containing respectively 5, 15, 25, 35 and 45 per cent. of the salt. The curves showing the electromotive force at given temperatures in the case of the 5, 25 and 45 per cent. solutions enabled Mons. Bagard to verify the law of intermediate bodies. It was experimentally demonstrated by opposing a couple of 5 and 25 per cent. in series with another of 25 and 45 per cent. to a third of 5 and 45 per cent., when no deflection of the electrometer was observed in the range of temperature 0°—73·3° Centigrade. The experimental work was carried out in the physical laboratory of the Faculty of Science at Nancy.

Electrolytic Bleaching.—The French Society for the Encouragement of National Industry appointed a short time ago, through their Committee of Chemical Arts, Mons. de Luines to report upon the bleaching process of Mons. Hermite. In this process the bleaching agent is produced by the electrolysis of a mixture of 1,000 parts of water, 50 parts of sodium chloride, and 5 parts of magnesium chloride. Mons. Luines's report states that only the magnesium chloride and the water appear to be decomposed, forming at the positive pole a compound of great decolourising power. It has been asserted by some of the critics of this electrolytic process, that free soda must necessarily be produced as a result of the reaction, but Mons. Luines says there is no fear of this, a fact which bears strongly in its favour. Some quantitative statements are made towards the end of the report, from which we extract the following for the benefit of those who are interested in electrolytic bleaching. An electrolyser of Hermite's system produces in 24 hours the equivalent of 100 kilos. of dry chloride of lime at a cost of 5·22 francs, if hydraulic power be used, or 10·02 francs if steam has to be employed. The report may be consulted in detail in the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, series [4] Vol. vii., No. 82.

High Frequencies from Direct Currents.—It is rumoured from America, says *Industries*, that Prof. E. Thomson has discovered a new way of producing high-frequency discharges. There is one method which, so far as we know, has not been tried yet. It was suggested by us before the Tesla experiments became fashionable as a convenient method of producing Hertz vibrations continuously and regularly. A direct current circuit has a resistance and an arc gap. In shunt to the arc gap is a circuit containing both capacity and self-induction in series, and the oscillatory current is produced in this circuit. The frequency varies inversely as the root of the product of the capacity and self-induction, and the main resistance can be adjusted to suit the circuit—that is to say, to make the current uniform from period to period, instead of having merely a succession of oscillatory discharges. Different currents of a given frequency can be produced by altering the capacity and self-induction without altering their product. The electromotive force is controlled by the length of the arc, but is, of course, greatest in shunt to the self-induction or to the capacity. Of course, this arrangement can be modified, but it seems to us to be much better than using a series of oscillatory discharges at short intervals, as is now customary with alternating transformers.

Lectures.—On Wednesday, February 8th, at 8 p.m., at the Whitgift Grammar School, Croydon, Mr. W. Perren Maycock, M.I.E.E., will lecture on "Electricity." After the lecture a conversazione and exhibition of apparatus will be held.

On Saturday last, Mr. H. Leonard Hinnell addressed the Manchester branch of the Sanitary Inspector's Association on "Sewage Purification"; he referred to three processes, one of these being the electrical method.

At a conversazione of the Caradoc Field Club at Shrewsbury last week, a paper entitled "The Sources and Uses of Electricity" was read by W. J. G. Barber Starkey.

On Wednesday, last week, Mr. Ernest A. Browning lectured in the Literary Institute, Edinburgh, on the subject "Electric Light in our Homes."

The first of a series of seven literary and scientific lectures was given in Fowey Grammar School, Plymouth, on Friday last, when Mr. J. M. Coon, of St. Austell, took as his subject, "Electricity and the Electrical Transmission of Power."

Electrical Meters.—Mr. E. Cunliffe Owen, secretary to the Metropolitan Electric Supply Company, has written to the *Evening Standard* regarding a leader published by our contemporary last week on the case decided in the Westminster County Court, to which case we referred in our "Notes" columns last week. In his letter Mr. Owen states that our contemporary's remarks on the subject "appear to have been based on a misleading report of a recent case decided at the Westminster County Court. I shall feel obliged if you will allow me to state briefly the law on the subject. Clause 62 in our Act provides that, should any difference arise between the consumer and the supply company as to whether any meter is or is not in proper order for correctly registering the consumption, the consumer is at liberty to have the meter tested by an electrical inspector appointed by the London County Council, whose decision shall be final; but, subject to this provision, the register of the meter shall be conclusive evidence of the value of the supply. In the case in question the defendant, whose quarter's consumption amounted to £3 17s. 4d. (or only 10d. per day for an installation of 30 lamps in a public-house), distinctly stated that he did not impugn the accuracy of our meter, but simply expressed an opinion that he had not consumed the quantity charged for."

The Proposed Electric Underground Railway for Brussels.—For a lengthened period now rumours have abounded as to the electric railway scheme for Brussels. Our contemporary, the *Indépendance Belge*, has now definitely settled the question by interviewing M. Alph. Müllender, the American Vice-Consul at Liége, and the promoter of the scheme. From this interview we learn that the railway will have no terminus, but will be in the form of a continuous circle. Taking the projected station near the Bourse as a starting point, the tunnel will pass under the sewers and under the Boulevard Anspach, and in its route will touch nearly all the principal thoroughfares of Brussels. The complete circuit of the city will be made in 15 minutes.

Some Mechanical and Electrical Analogies.—In Messrs. Bedell and Crehore's article on another page in this issue are some mechanical and electrical analogies, many of which, it is believed, appear now for the first time. The tables were prepared for lecture notes, and are soon to be published in an appendix to the author's work on "Alternating Currents."

Windsor Castle Electric Lighting.—The *Daily News* Windsor correspondent says: The arched roof of the Chamber leading to the electric light station in the north terrace at Windsor Castle has been opened preparatory to some alterations which are about to be made in the machinery of the Palace installation. The electric light is now better appreciated at the Castle, and when the Queen was last in residence the east corridor between the Royal private chapel and Her Majesty's dining room at the Victoria Tower was very successfully illuminated by glow lamps. There is reason to believe service will be gradually introduced to other apartments.

A New French Telegraph Cable.—On Wednesday morning of last week was commenced, at Marseilles, the laying of the submarine cable which is intended to connect that port with Tunis. This cable was commenced on October 15th of last year, and was finished on January 3rd of this year. It has occupied 250 men per day, and is 1,158 kilometres in length. The cost of the cable was 2,650,000 francs (£16,000).

Torquay Electric Lighting.—The Electric Light Committee have recommended that offers be invited from companies and persons for transference to them, by way of lease, of the powers contained in the electric lighting order. The council have referred the matter back to the committee, with instructions to them to obtain the advice of an expert.

Southport Electric Lighting.—Last week the first experiment in the public lighting of the town by electricity was made, when a Brush parallel arc lamp af 2,000 candle-power was lit on the landing stage of the North Lake. The experiment was considered satisfactory.

The World's Fair Electrical Congress.—Preparations are being made for the Electrical Congress to be held at Chicago. In our other columns we give full particulars of the programme. The New York *Electrical Engineer*, in an interesting leader on the subject of this programme, draws special attention to the excellent suggestion of the General Congress Committee, that an International Congress is the place to close, but not to open, a discussion on questions involving international agreement. A meeting of the Advisory Council was held on January 17th. It was resolved that the Electrical Congress of 1893 shall consist of two Chambers, of which the Legislative Chamber shall decide on units, names of units, and standards, and shall consist solely of delegates named by their respective Governments. The total number of delegates to be appointed is 55, in which are included five from Great Britain. The meetings will be open to the public, for attending the proceedings, but not for taking part therein. The Congress is to last one week, beginning on August 21st.

Singapore Electric Lighting.—A number of letters have been appearing in the Singapore *Free Press* lately, from the pens of Mr. O. V. Thomas, Mr. James MacRitchie, and Major H. E. McCallum, regarding the proposed electric lighting installation in that town.

Fatal Accident.—A sad fatality occurred at the works of the Brighton and Hove Electric Light Company, Glo'ster Road, on Wednesday last week. A labourer named George Sherwood was engaged upon the extensions being carried out in the works, when he fell from the ladder upon which he was standing, and struck his head on the fly-wheel of the new engine, in course of erection, a distance of about 5 feet. He was at once picked up, and was then found to be dead. Sherwood, who had been in the employ of the Electric Light Company for about a year, was a middle-aged man, and leaves a wife and seven children.

Accident on the Edinburgh Cable Tramways.—A slight misbap occurred to one of the Goldenacre cable cars last week as it was crossing the point at George Street, Edinburgh. Probably, owing to the car being run at greater speed than is usual at this part of the line, the hind bogie "jumped" the point, causing it to leave the rails. The unusual occurrence caused considerable excitement, and for some time the traffic was impeded.

Institution of Electrical Engineers.—On Thursday next, February 9th, Prof. Fleming will reply to the discussion on his paper on "Experimental Researches on Alternate Current Transformers." Mr. W. M. Mordey will read a paper on "Note on Testing Alternators."

The Junior Engineering Society.—The eighth annual dinner of this society was held on Saturday evening last in the Queen's *salon* of the Holborn Restaurant. The president, Dr. John Hopkinson, F.R.S., took the chair. Among the company were Sir George Gabriel Stokes, F.R.S. (vice-president); Sir Frederick Abel, K.C.B., F.R.S.; Mr. W. H. White, C.B., F.R.S., Director of Naval Construction (vice-president); and Prof. John Perry, F.R.S. (past president).

Liverpool Overhead Railway.—The Mayor of Liverpool has invited all the members of the City Council to the banquet to Lord Salisbury, who goes to Liverpool to-morrow to open the overhead railway.

The Inventor of Gutta-Percha Covered Wire.—In a letter in the *Engineer*, Mr. F. H. Danchell, a Danish engineer, claims to be the original inventor of gutta-percha covered wire. The letter is as follows :—"I do not remember the exact date, but I think it was between 1840 and 1845, that I heard a paper read at the Society of Arts upon gutta-percha, where some of it was shown as a curiosity; on application I obtained some of it for experiment; the peculiar properties of it gave me the idea that it might be used with advantage for covering wire for electric telegraphs. I succeeded in doing this, and showed a specimen of it to an agent of a noted American firm, who at that time happened to be in London to take orders for electric communications. He thought very highly of it, and advised me to go to Berlin and apply for a patent, as the Prussians were making great advances in adopting the electric telegraph communication; in England I could take no steps, as a Quaker firm had obtained a patent for the application of gutta-percha generally. I took his advice and applied in Berlin for a patent, and was told by the Royal Commissioners that they could not grant a patent without seeing how it was done; for this purpose I had to get a machine made to show how the wire was to be covered with gutta-percha. The English Consul, Mr. Eliot, introduced me to an engineering firm for this purpose; their name was, if I do not mistake, Siegel. When the machine was made I apprised the Royal Commissioners that I was prepared to show them the process, and they appointed a day to attend. With the two Commissioners came Ernst Werner Siemens, then a young officer in the Prussian service, who seemed to be a special friend of theirs. They satisfied themselves about the process, and promised that I should hear from them. After waiting a fortnight and not receiving any communication, I called upon the principal Commissioner, when I was informed by him that the matter was too important to give anyone the monopoly of it, but that shortly tenders would be applied for, for a line between Berlin and Frankfurt, in which case I would have the best chance to recoup myself for any expenses. I sent in my tender, but was astonished to find that a connection of Siemens had got the order. On enquiry I found his tender was very slightly below mine. I leave it to you and others to judge the fairness of these proceedings, but, at any rate, Mr. Siemens or his friends have no right to call the invention his. As a matter of fact, I cannot find any English patent application in the name of Siemens till 1852, but in that year E. W. Siemens had a patent for electric telegraphy, and in the specification is described and claimed a specific construction of machine for covering wire with gutta-percha, and he states wherein the difference lies between that machine and other machines for accomplishing the same purpose. I believe gutta-percha covered telegraph wire was first used in 1847 on the aforesaid Berlin-Frankfurt line, and next in 1848 for submarine purposes in the harbour of Kiel and adjoining waters, during the Dano-German war, and that by the then Lieutenant E. Werner Siemens for the Prussian Government, who thus secretly supported the revolt against Denmark." Mr. Alexander Siemens since writes to the *Engineer* as follows :—"I must protest against the statement which is contained in the letter of Mr. Danchell, where he says: 'With the two commissioners came Ernst Werner Siemens, then a young officer in the Prussian service, who seemed to be a special friend of theirs.' Any of your readers would imagine from this insinuation against the Royal Commissioners that Ernst Werner Siemens accompanied them without any due authority, and for purposes of his own, but at the time of which Mr. Danchell speaks Ernst Werner Siemens had held the rank of lieutenant for 12 years. He was himself a member of the Royal Commission in question, to which he had been appointed a year previously with the object of developing his invention of covering wires with gutta-percha. It is particularly ungracious to raise the question of priority now that Dr. von Siemens is no longer with us to repel such attacks. Happily, however, the question was settled some years ago in a court of law, when it was argued in the case of Colgate *v.* Western Union Telegraph Company before the U.S. Circuit Court, Southern District of New York. During the progress of the suit, a specially-appointed Commission was sent to Germany thoroughly to investigate the matter. After an exhaustive search of the official records, and after advertising in many papers inviting information from any person, the Commission was able to report that the claim of the late Dr. Werner von Siemens to be the inventor of gutta-percha covered wire was fully made out. I need only add further, with reference to the concluding sentence of your correspondent's letter, that Lieutenant Siemens was not sent to Schleswig-Hölstein by the Prussian Government until after war had been declared."

An Application of Electroplating to the Decoration of China, &c.—A method is now being exploited in the Potteries, the purpose of which is the deposition of metals, such as copper and silver, on certain portions of the surfaces of china and earthenware articles, with the view of ornamenting them, and of giving them, at the same time, additional strength. The surface of the articles to be treated is first coated with a paste containing the following ingredients :—

	Parts by weight.
Nitrate of silver	120
Ammonia chloride of mercury	20
Bromide of sodium	30
Oxide of bismuth	10

The articles of china or earthenware thus prepared, are fired in the pottery kilns. They are then placed in an electroplating bath, when the prepared surface is found to take a strongly adherent metallic coating. A very thick deposit (*e.g.*, of copper) is said to greatly strengthen handles, spouts, &c.

Southampton Library Electric Lighting.—A report has been prepared regarding the proposed installation of electric light at the new Library Buildings. The report states, the comparative cost of electric light and gas appears to stand as follows :—"Electric light: Principal and interest on capital expenditure, £355; borrowed for 20 years, £22; gas consumed by engine, at £1 per week, £52; a total of £74. Gas: Consumed for lighting purposes, 6 feet burners, £93 12s.; destruction to painting, &c. (estimated), £20; total, £113. These figures showed a saving in favour of electric lighting of £39 12s., but against this must be placed some extra cost for superintendence and renewals of lamps, &c., and the cost of engine house. If burners consuming 5 cubic feet per hour were used instead of 6 cubic feet burners the saving would be £24. The sub-committee, therefore, recommended that the electric light should be adopted, and that they be empowered to arrange all the necessary details for carrying out the work." The report was adopted, and application is to be made to borrow the necessary money for carrying out the work.

Newark Electric Lighting.—The old waterworks has been found unsuitable for producing electric lighting, and a separate plant is recommended. The Corporation has, however, decided that they cannot now undertake the scheme, but will offer every facility to private enterprise in the way of providing a Provisional Order.

Brighton Electric Lighting.—It is proposed to introduce the electric light into the Brighton School of Science and Art as soon as practicable, and a sub-committee has been appointed to report as to the purposes for which the light can be used.

Tunbridge Wells Electric Lighting.—Mr. W. H. Preece and the Electric Lighting Committee have prepared reports regarding the electric lighting question. It is proposed in these reports to borrow £13,000 for carrying out the necessary work.

Blackpool Electric Lighting.—A Local Government enquiry as to the borrowing of £26,000 for electric lighting extensions was held on Tuesday last. In the course of some remarks, the Town Clerk said that electric lighting had become indispensable at Blackpool.

Kensington Electric Lighting.—A monthly meeting of the Ratepayers' Association was held last week on the question of the electric lighting of the district. A suggestion was made that the vestry should purchase the undertakings of the companies and supply the light themselves.

Cardiff Electric Lighting.—A number of letters have been appearing lately in the *Western Mail* on the subject of the cost of electric lighting compared with that of gas at Cardiff.

Whitechapel Electric Lighting.—The Streets Committee have been instructed to consider the electric lighting question, and report from time to time.

NEW COMPANIES REGISTERED.

Easton & Bessemer, Limited.—This company was registered on the 24th ult. with a capital of £10,000, in £5 shares, to purchase and acquire the business carried on at Taunton under the style of Easton & Waldegrave, and known as the Whitehall Iron Works, and to follow the trade of ironfounders, metallurgists, electrical and general engineers, and other similar businesses in England or elsewhere. The subscribers (with one share each) are :—W. W. Easton, engineer, Taunton ; H. W. Bessemer, engineer, Taunton ; H. E. Easton, land agent, Weston-super-Mare ; W. Pring, brewer, Exeter ; H. Grierson, solicitor, Southampton ; E. Gulford, solicitor, Southampton ; F. C. B. Clark, manufacturer, Kensington, W. The regulations of Table "A," with some slight modifications, apply. Registered by Waterlow and Sons, Limited, London Wall, E.C.

British Association of Medical Electricians, Limited.—This association was registered on the 24th ult. as a concern limited by guarantee, every member agreeing to contribute a sum not exceeding £5 to the assets in case of liquidation, to purchase all the rights and property of every kind possessed by the unlimited company called the British Association of Medical Electricians, and to promote and encourage the study and practice of medical electricity. The subscribers are :—H. Tibbits, M.D., Cavendish Square, W.; C. B. Harness, 52, Oxford Street, W.; R. A. Daniel, 15, St. Charles Square, W., M.B.; C. Lemprière, D.C.L., Oxford; J. M. McCully, M.D., Portman Square, W.; R. Wallace, M.B., 39, Oxford Gardens, W. The first president of the association is to be Mr. C. B. Harness, and he is to hold office for seven years from the date of incorporation. Registered by Charles Doubble, 14, Serjeant's Inn, E.C.

Printing Telegraph and Construction Company of the Agence Havas, Limited. — This company was registered on the 12th ult. with a capital of £130,000 in £5 shares ; to acquire by purchase or on royalty, or otherwise, the exclusive, or non-exclusive, or limited right to use and vend within the Republic of France ; and to grant licenses for the using and vending of all or any of the inventions relating to printing telegraphs, or any of the inventions relating to improvements in these ; to enter into a specified agreement, and to use and develop, or otherwise turn to account the property and rights of the company. The subscribers (with one share each) are T. E. Polden, publisher, 2, Amen Corner; W. Seymour, gentleman, 9, Ovington Square ; W. A. Pittman, gentleman, Harlesden, N.W. ; P. W. Bullock, gentleman, Bryanston Square, N.W. ; Wm. H. Stentiford, clerk, Maida Vale, W.; E. R. Polden, publisher, 2, Amen Corner, E.C. ; W. J. Watchurst, printer, New Brompton. The number of directors is not to be less than three nor more than seven. Qualification, £500. Remuneration to be fixed by a majority of the subscribers of the memorandum of association of the company. Registered by Slaughten & May, 18, Austin Friars, E.C.

St. Martin's Electrical Manufacturing Company, Limited.—This company was registered on the 21st ult. with a capital of £500, in £5 shares, to manufacture and put up, or to acquire and use telephones, telegraphs, electric bells, phonographs, electric light, and all other electrical apparatus now known, or that may be hereafter invented, including formation of electrical exchanges or centres. The subscribers (with one share each) are :—John Kennedy, 69, Cheveland Street, W., clerk ; J. B. Lambe, Throgmorton House, E.C., secretary ; C. B. Andain, 38, Coleman Street, E.C., clerk ; C. E. C. Hancock, Kensington, electrical engineer ; J. H. Blackley, Brondesbury, N., clerk ; T. D. Dundas, 78, Cambridge Gardens, W., electrical surveyor ; J. Parrett, Homerton, clerk. Registered by W. Alexander Thompson, 38, Coleman Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Elmore's Patent Copper Depositing Company, Limited.—The annual return of this company has been made up to January 13th, and shows that 91,195 shares of £2 each of a total of 100,000, have been taken up, of which 23,300 have been issued as fully paid. The full amount has been called on the remaining 67,895 shares, resulting in the payment of £135,797 10s., which includes £17 10s. paid on 15 forfeited shares.

Elmores' Foreign and Colonial Patent Copper Depositing Company, Limited.—The annual return of this company has been made up to the 6th ult., and shows that the total capital of 15,000 priority and 9,000 founders' shares of £5 each has been taken up, of which 6,000 founders' shares were issued as fully paid. Upon the remaining 15,000 priority and 3,000 founders' shares the full amount has been called, resulting in the payment of £90,020. In addition to this, £20 has been paid on 20 priority and 20 founders' shares, forfeited.

Law's Electrical Appliances Company, Limited.—It was resolved at a meeting of this company, held at 40 & 42, Queen Victoria Street, on the 9th ult., to wind up this company voluntarily.

Elmore's Wire Manufacturing Company, Limited.—The annual return of this company, made up to January 13th, shows that out of a nominal capital of £300,020, divided into 150,000 ordinary and 10 founders' shares of £2 each, 67,528 ordinary and 10 founders' shares have been taken up. The full amount has been called on these shares, the result of which is a sum of £129,587 3s. 8d., leaving £5,488 16s. 4d. unpaid. Besides this £390 has been paid on 1,360 forfeited shares.

Gordon Electric Traction Syndicate, Limited.—The annual return of this company has been filed, and on January 5th showed that out of a nominal capital of £2,400 in £10 shares, 233 have been taken up. The full amount has been called on 173 of these shares, and all calls (£1,730) paid. The remaining 60 were issued as fully paid.

International Electric Syndicate, Limited.—According to a notice filed at Somerset House, Mr. Justice Vaughan Williams has ordered that this company be wound up under the provisions of the Act, 1862 and 1890, and that Mr. C. J. Stewart, the Official Receiver attached to the Court, be constituted provisional liquidator.

Italian Electric Light and Power Company, Limited.—The annual return of this company, made up to December 20th last, and filed on the 3rd ult., shows that out of a nominal capital of £60,000, in 15,000 £4 shares, 307 shares have been taken up. The total amount agreed to be considered as paid on 300 shares is £1,200. There has been nothing called up.

J. C. Howell, Limited.—The statutory return of this company, made up to November 1st last, shows that out of a capital of £25,000 in £5 shares, 2,907 have been taken up. There has been £5 called on each of 907 shares, and the total amount of calls received reaches £4,510. The sum agreed to be considered as paid on 2,000 shares is £10,000. There is £25 unpaid.

Morecambe Electric Light and Power Company, Limited.—The first annual return of this company, made up to the December 27th, shows that out of a nominal capital of £15,000, in 14,950 ordinary and 50 founders' shares, all of £1 each, 3,836 ordinary, and the whole of the latter class have been taken up. Of these 851 ordinary shares have been issued as fully paid, although no agreement explaining such issue has been filed. The founders' shares have been paid in full, and 16s. per share has been called on the remaining 2,985 ordinary shares, resulting in a payment of £2,350 10s.

Chas. Churchill & Co., Limited.—The annual return of this company, as filed at Somerset House, shows that out of a nominal capital of £6,000, divided into 140 preference shares of £25 each, and 50 ordinary shares of £50 each, 103 preference and 40 ordinary shares have been taken up, and that £25 has been called on each of 53 preference shares. The total amount of calls received, including payments on application and allotment, is £1,325. The sum agreed to be considered as paid on 50 preference shares is £1,250, and on 40 ordinary shares £2,000. There are no calls unpaid.

Leeds and London Electrical Engineering Company, Limited.—At an extraordinary general meeting of this company, held at 117, Bishopsgate Street Within, E.C., on December 12th last, special resolutions were passed and subsequently confirmed, modifying the regulations of the company. At the present time the nominal capital is £100,000 in £5 shares, and, according to the last return, only seven shares were taken up. No calls were paid.

Home Telephone Company, Limited.—The annual return of this company shows that out of a capital of £500 in £5 shares, the whole of these have been taken up. There has been £100 paid, including payments on application and allotment.

Universal Arc Lamp Syndicate, Limited.—The statutory return of this concern has been made, and it appears that out of a nominal capital of £3,000 in £1 shares, 2,865 have been taken up. A call of 1s. 6d. per share has been called upon these, which makes an amount of £228 15s., which includes a sum of £1 paid on 15 shares.

Liverpool and District Pulsion Telephone Company, Limited.—It has been proved to the satisfaction of the shareholders of the above concern, that the company cannot, by reason of its liabilities, continue its business, and it was accordingly determined to wind up voluntarily. Mr. J. M. Wade was appointed liquidator.

Henley Telegraph and Electric Construction Company, Limited.—At an extraordinary general meeting of this company, held at 6, Clement's Lane, on December 15th last, a resolution was passed, which was confirmed on the 21st of the same month, to the effect that the concern should be wound up voluntarily.

Crompton Electric Supply Company of Australia, Limited.—The annual return of this company has been made up to the 1st inst., and shows that out of a nominal capital of £50,000, in 9,500 "A" and 500 "B" shares of £5 each, that 3,115 "A" and 500 "B" shares have been taken up. The "B" shares were issued as fully paid, and £15,020 has been called on the other class. There is an amount of £555, however, in arrears.

Crystal Palace District Electric Supply Company, Limited.—The annual return of this company has been made up to the 4th ult., and shows that out of a capital of £100,000, formerly in £10 shares, but now altered to £1 each, that 31,850 have been taken up, of which 17,430 were issued as fully paid. Upon the remaining 14,420 shares the full amounts have been called, and all calls (reaching £14,420) paid.

Electric Lighting and General Development Syndicate, Limited.—The statutory return of this company has been made, and shows that out of a nominal capital of £700 in £10 shares, 48 have been taken up. There has been £280 paid, and a further £200 has been agreed to be considered as paid. On August 29th last the registered office was at 31, Crutched Friars, E.C.

Electric Cycle Syndicate, Limited.—The statutory return of this syndicate has been filed at Somerset House, and shows that out of a nominal capital of £3,000 in £1 shares, 1,921 shares, with 10s. called on each, have been taken up. The total amount of calls received is £380 10s.; £1,000 has been considered as paid, and £80 is still in abeyance.

Gordon Electric Traction Syndicate, Limited.—From the annual return of this company, made up to 5th ult., it appears that out of a capital of £2,400 in £10 shares, 233 shares have been taken up, with £10 called on 173 of these. There have been 60 issued as fully paid. The total amount of calls received is £1,730, and the sum agreed to be considered as paid reaches £600.

J. C. Howell, Limited.—The statutory return of this company, made up to November 1st, 1892, shows that out of a nominal capital of £25,000 in £5 shares, 2,907 of these have been taken up, with £5 called on each. The total amount of calls received is £4,510, and that considered as paid, £10,000. The sum of £25 remains unpaid.

Venezuela Telephone and Electrical Appliances Company, Limited.—The annual return of this company has been made up to December 15th, 1892, and shows that out of a nominal capital of £70,000 in £1 shares, 56,756 shares have been issued as fully paid. Upon the remaining 13,244 shares the full amounts have been called and all calls paid. The result of this is £13,244.

Williamson Electrical and Engineering Company, Limited.—The annual return of this company, made up to December 22nd, shows that out of a nominal capital of £5,000 in £10 shares, raised on July 3rd, 1891, to £25,000, that 500 shares have been taken up, the full amount paid, and all calls remitted. This sum reaches £5,000.

International Electric Subway Company, Limited.—The registered office of this company is now situate at 43, Threadneedle Street, E.C.

Globe Electric Company, Limited.—The registered office of this company is now situated at 6, Ropemaker Street, E.C.

International Electric Subway Company, Limited.—The registered office of this company, according to the latest file at Somerset House, is at 39, Victoria Street, Westminster, S.W.

International Okonite Company, Limited.—The registered office of this company is situated at 34, Cannon Street, E.C.

Loughborough Electricity Supply Co., Limited.—The registered office of this company is now situated at 112, Belvedere Road, S.E.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belfast.—February 10th. For the supply of copper, and other wire, for the Belfast and Northern Counties Railway Company. Further particulars from Mr. Ellis, York Road Station, Belfast.

Berne.—February 20th. For the supply of bronze wire, telegraph posts, insulators, &c., and various telegraphic apparatus for the Swiss Telegraphs Administration. Further particulars from the Store Department, Rue des Ganiers, Berne, Switzerland.

Blackburn.—February 18th. For the supply of iron lamp pillars, sheet brass, copper, &c., for the Corporation. Further particulars from the Borough Engineer, Mr. J. B. McCallum, Municipal Offices, Blackburn.

Gosforth.—No date. For the installation of the electric light in premises for the Gosforth Steam Laundry Company, Limited. Further particulars from Messrs. Oliver & Leeson, 30, Mosley Street, Newcastle-on-Tyne.

Kingston-upon-Thames.—February 11th. For the supply, construction, and laying down plant and mains for the supply of electricity for the Corporation. Further particulars from Mr. Harold A. Winser, Town Clerk, Kingston-upon-Thames.

Leeds.—No date. For the installation of electric lighting in the *Yorkshire Post* offices. Further particulars from the manager, 23, Albion Street, Leeds.

London.—February 7th. For the supply of copper pipes for the India Office. Further particulars from the Director-General of Stores, India Office, Whitehall, S.W.

London.—February 7th. For the supply of copper plates for the South Indian Railway Company, Limited. Further particulars from Mr. Henry W. Notman, 55, Gracechurch Street, E.C.

Lisbon.—February 9th. For the supply of copper and brass wires, &c., for the Portuguese Royal Railways Company. Further particulars from the Agent of the Company, 39, Rue de Chaussée-d'Antin, Paris.

Manchester.—February 7th. For the supply of brass and copper wire, sheets, &c., for the Manchester Ship Canal. Further particulars from Mr. A. H. Whitworth, secretary, 41, Spring Gardens, Manchester.

Nièvre (France).—February 28th. For a lighting installation, Château-Chinon, Nièvre, France.

Ploesti (Roumania).—March 22nd. For the electric lighting of the town for the municipal authorities, from whom further particulars may be obtained.

BUSINESS NOTICES, &c.

Electric Lighting Tenders.—On Friday last the Electric Lighting Committee of the Portsmouth Town Council considered tenders for the electric light installation in the borough in accordance with Prof. Garnett's scheme. The contracts were divided under three heads, Section I. being for boilers and engines, Section II. for alternators, dynamos and other apparatus, and Section III. the steam turbine engine which it is intended to use for day work. The tenders were opened as under:—

	Section I.	Section II.	Section III.
Electric Construction Co.	£15,441	£8,652	—
Brush Company	£15,850	£9,360	£1,750
Willans	£18,086	—	—
Ferranti	£18,094	£11,618	£1,750
Hammond & Co.	£16,906	£10,691	£1,876
Bellis & Co.	£21,500	—	—
Statter	£16,671	£9,787	£2,000
Siemens	—	£8,644	—
Leaf	—	£13,500	—
Fullerton	£14,500	—	—
Yates & Thom	£14,280	—	—
Sharp & Kent	£16,875	—	—
Parsons & Co.	—	—	£1,750
Laing, Wharton & Down	—	£11,127	—
Johnson & Phillips ...	—	£9,347	—
Watt & Co.	£13,780	—	—
Drake & Gorham ...	—	£11,900	£1,855
Clarke & Co.	£14,484	£8,654	£1,837
Adamson & Co.	£16,050	—	—

The committee, after careful consideration, determined to recommend the Town Council to accept the tenders of Messrs. Yates & Thom, of Blackburn, £14,280 for the boilers and engines, of the Electrical Construction Company, London, £8,652 for the alternators, dynamos, &c.; and of Messrs. Parsons, £1,750, the makers, for the turbine engine. The work is to be completed within six months of the contract being sealed. Tenders have yet to be received for street mains, which are estimated to cost about £10,000, and for lamps for public lighting. Everything is progressing satisfactorily, and there seems good reason to believe that by the autumn the electric light will have become an accomplished fact in Portsmouth.

Catalogues, &c.—Messrs. O. Berend & Co., have just brought out a small pocket catalogue for 1893. In this book of 36 pages are described electrical and general engineering manufactures, such as telephones, switches, cut-outs, Hartmann and Braun's measuring and testing instruments, complete electro-plating outfits, influence machines, pole-finding paper (a sample of which is given with the book), tempered copper, pumps, filters, &c., &c. In the front of the book there is an 1893 calendar, particulars of the standard wire gauge, and an alphabetical list of the firm's supplies. This is a catalogue of convenient size to carry in the pocket. We presume this book is merely to give an idea as to the class of goods sold by the firm, as details are not entered into. A complete catalogue is now in preparation.

A list of the principal electric light installations carried out by Messrs. Edmundsons, Limited, of Great George Street, has been sent us in pamphlet form. The list is divided into three heads, *i.e.*, installations supplied with engines, dynamos, and accumulators; private houses fitted for supply from central stations; ships, yachts, &c., lighted. A number of testimonials are given at the end of the book. On the front cover by way of novelty there is a full page illustration of the signal light on the House of Commons' Clock Tower, which is a very striking advertisement for the firm.

Messrs. R. Stephenson & Co., Limited., of Newcastle, has sent us one of their 1893 calendars. On the front of this is a very nice illustration, printed in several colours, of a locomotive.

Electric Lighting in the West End.—Since last week we have paid another visit to the former district and find that an additional number of wiring contracts are in hand or have recently been completed, among which we may mention that Messrs. Girdlestone & Tatham, of Duke Street, Berkley Square, are fitting up the premises of Messrs. Sandland & Crane, 55, Regent Street. Electric light work has also recently been carried out in the premises of Messrs. A. & P. Kuchemann, umbrella makers, Rupert Street, Piccadilly Circus, also in the premises of Mr. G. Mellin, chemist, Piccadilly Circus; in the shop of Messrs. O. Newman & Co., 101, Regent Street; also for the Crown Boot Company, 205, Regent Street; for Mr. G. Salviati, 213, Regent Street; and in the premises of the Singer Manufacturing Company, 274, Oxford Street; and Mr. John Stait, letterpress and lithographic printer, 323, Oxford Street. In the Holborn district several contracts have recently been completed, including one in the premises of Messrs. Matthews, Drew and Company, law stationers and printers, 37, High Holborn; one for Mr. W. Page, portmanteau manufacturer, 69, High Holborn.

Mr. S. B. McClellan, 26, Ludgate Hill, has secured the contract for lighting the extensive mansions lately erected by Messrs. Grover and Son in Charing Cross Road and St. Martin's Lane, these installations when completed will comprise upward of 600 16-C.P. incandescent lamps. Messrs. Gatti will in all probability supply the current.

Bolton Electric Lighting.—The Town Council have approved of the recommendation of the Gas Committee to apply for powers to borrow £40,000 for electric lighting purposes. The Committee have now before them tenders from six firms for laying down an installation, the estimates varying from £8,340 to £13,430, in addition to which there will be cost of buildings. The estimated cost and producing capacity of the plant by each firm for the compulsory area is as follows:—The Brush Company, capacity 3,000 16-C.P. lamps, cost £11,187; Crompton & Co., capacity 2,000 16-C.P. lamps, cost £12,890; Electric Construction Corporation, capacity 2,000 16-C.P. lamps, cost £8,340; Ferranti, capacity 2,500 16-C.P. lamps, cost £13,430; Parson's and Co., capacity 2,500 16-C.P. lamps, £12,600; Siemens, scheme A (low tension), capacity 3,000 16-C.P. lamps, cost £12,700; Siemens, Scheme C. (high tension), capacity 3,000 16-C.P. lamps, cost £9,700. Preparatory to coming to any decision the sub-committee propose visiting Birmingham. Meanwhile it is proposed to advertise for a resident electrical engineer at a commencing salary of £200 per annum.

The House of Commons' Signal Light.—During the Parliamentary recess a great improvement has been made in the signal light on the Clock Tower at Westminster. This light which is kept burning whenever the House is sitting, was used in its new form for the first time on Tuesday evening last. Previously the light was only visible over the western districts, but it has now been made to show a light in every direction. The same powerful Wigham gas-burner is retained that has been in use since the signal light was first established 20 years ago, but dioptric lenses have been added which very greatly increase the power of the light. The light is 250 feet from the ground, and the Clock Tower is now a powerful lighthouse, throwing a beam visible many miles in all directions, and the system is the same as adapted to many of our coast lighthouses. The work has been carried out by Messrs. Edmundsons, Limited, of Westminster and Dublin.

Scarborough Electric Lighting.—The Scarborough Electric Supply Company, Limited, who have obtained a transfer of the provisional order for Scarborough, secured by the Corporation, are now getting to work. A site for the supply station has been decided upon at Salisbury Street, on the west side of the town near the railway, and building operations will be commenced forthwith. The contract for the whole of the generating plant, including engines, alternators, condensers, boilers, &c., has been placed with Messrs. C. A. Parsons & Co., of Newcastle-on-Tyne, whose price was considerably less than the other tenders received in response to the specification, and who also guaranteed with their steam turbine alternators the lowest steam consumption per unit at all loads.

J. E. H. Gordon & Co., Ltd.—At an extraordinary general meeting of the members of the above company, duly convened and held at 11, Pall Mall, on January 30th, 1893, the following extraordinary resolution was duly passed:—"That it has been proved to the satisfaction of the members that the company cannot, by reason of its liabilities, continue its business, and that it is advisable for this reason and other reasons connected with the proposed amalgamation to wind it up, and that the company be therefore wound up voluntarily; and that James Drayson Austen Norris, of Suffolk House, Laurence Pountney Hill, E.C., chartered accountant, be and he is hereby appointed voluntary liquidator hereof."

New Patent "Claw" Grid.—The Electrical Power Storage Company, Limited, are introducing a new form of patent "Claw" grid for their negative plates generally, and for both denomination of plates in selected instances. The peculiar construction enables a large pellet, and consequently a large amount of paste or other active material to be used in the electrode, while the conducting surface is largely increased, and the grip for such active material applied by the peculiar "Claw" shape ensures that the porous lead or peroxide is firmly held in position, while permitting perfect freedom for expansion or contraction in the mass of the pellets of active material.

Electric Lighting in the City.—Among the new work as regards private installations at present in hand we notice that Mr. H. Connolly, of Hampstead Road, St. Pancras, is fitting up the premises of Mr. B. G. Skipworth, 42, Sise Lane, Queen Victoria Street.—Messrs. J. D. F. Andrews & Co., are engaged in the premises of the London Chamber of Commerce, Eastcheap. An installation is being carried out in Eastcheap Buildings, Eastcheap. The contract is in the hands of Messrs. Walter Andreae & Co., of Lower Belgrave Street.—Messrs. Crompton & Co., are carrying out an installation in some new premises at 6, Tokenhouse Yard.

Mill Electric Lighting.—Messrs. J. and J. L. Peate have had the greater portion of their Nunroyd mills fitted up with the electric light, which was tested for the first time last week, and found to answer most satisfactorily. The installation has been carried out by Mr. Wilson Hartnell, electrician, Volt Works, Basinghall Street, Leeds. The dynamo is capable of supplying 600 lights. About 495 small lamps, each of 16 candle-power, and six 50-candle-power, have been fixed, the places lighted by the electric light being the condensing and spinning rooms, willey-house, dye-house, finishing and packing room, offices and outside of yard.

Runcorn Electric Lighting.—After consultation with Mr. Hall, electrical engineer, Liverpool, the General Purposes Committee of Runcorn Board of Commissioners, are of opinion that a case has been made out for lighting the public streets of the town by electricity, and they will recommend the board, at the next monthly meeting, to instruct Messrs. A. Hall & Co., electrical engineers, Liverpool, to prepare a complete and detailed report, specification, and estimate on the whole question.

Electrical Trades' Smoking Concert.—After a very pleasant football match was played on Saturday last, at Charlton Park, between the employés of Messrs. Johnson & Phillips and Siemens Brothers & Company, Limited, the former gave a complementary smoking concert at the King's Arms Hotel, Woolwich. The concert, which was organised by Mr. Mould (captain), and Mr. Sheppard (secretary), of Messrs. Johnson & Phillips's team, took place in the concert room of the King's Arms, and was filled with employés of the two local electrical engineering firms.

Bristol Electric Lighting.—The Bristol Electrical Committee met on Friday and again considered the tenders for distributing mains which range from £24,000 to £14,700. The Committee had previously decided to recommend the Council to accept the tender of Siemens & Co. for £17,200, subject to certain modifications which would bring it down to £16,580. The three lower tenders were £16,400, £15,700, and £14,700, but Mr. Preece regretted that they did not comply with the specifications. The former decision was adhered to but the question will be raised in council.

Chicago Exhibition.—The Corporation of the City of Birmingham have granted, through the United States Commission, the loan of the Woolrich magneto-electric machine to Messrs. J. E. Hartley & Son, of Birmingham, who will exhibit it at the World's Columbian Exposition, Chicago. As this machine was the forerunner of all the magnificent dynamos now so extensively used, it cannot fail to excite interest in the United States, where Faraday's great discovery has had so many practical applications.

"Unique" Switches.—Mr. A. P. Lundberg writes us regarding the continued success of his "Unique" switches, and combination switch wall sockets, which are daily increasing in popular favour and are being sold in large quantities both in this country and abroad. He has just received an order from France for 2,500 "Unique" combination switch wall sockets.

MacMahon's Patent Electric Check System, Limited.—A general meeting of the members of the above company is to be held at Salisbury Hotel, Salisbury Square, E.C., on March 3rd at 3 o'clock for the purpose of having an account of the manner in which the winding up of the company has been conducted, and receiving other information regarding same.

Country House Lighting.—Mr. C. B. Balfour is having Newton Don, Kelso, fitted with the electric light, and has entrusted the work to Mr. A. A. Campbell Swinton, electrical engineer, Westminster. Some 300 electric lamps will be employed to light the house and stables.

Charging Accumulators.—We are informed that the Sherborne Electric Installation Company, of Sherborne, Dorset, are now in a position to undertake the charging of small accumulators either at Sherborne, or their Dorchester and Weymouth branches.

Bournemouth Electric Lighting.—Messrs. Goddard, Massey & Co.'s scheme, for the electric lighting of the Pier and Gardens, has been selected by the Electric Lighting Committee as the best method of carrying out the work.

Antwerp Electric Lighting.—The Antwerp Hydro-Electric Company has concluded arrangements with the German-Austrian Mannesmann Tube Works, for the supply of seamless tubes for the high pressure system in Antwerp.

Personal.—Mr. W. Perren Maycock, M.I.E.E., has started in practice as a consulting electrical engineer, with offices at 96, George Street, Croydon.

CITY NOTES.

Elmore's French Copper-Depositing Company, Limited.

AN extraordinary general meeting of Elmore's French Copper-Depositing Company, Limited, was held yesterday at the Cannon Street Hotel, under the presidency of Major Charles Jones, R.A.

The CHAIRMAN said that in April last it was decided, on the recommendation of the board, to increase the nominal capital of the company by the creation of 100,000 preference shares of £2 each, power was taken to issue 60,000 of these shares so as to raise £120,000 additional working capital, which was considered necessary to meet the liabilities of the company, and to enable the management to push the manufacture on the large scale for which their works at Dives had been erected. Had that capital been fully subscribed they would have proved months ago not only that the Elmore process was a commercial success, but also that it was a financial success. Unfortunately, through various causes, the principal being, in his opinion, the delay of the English Elmore Company at Leeds to make their business a financial success, confidence in the Elmore affairs had been shaken, and consequently their preference issue was not responded to sufficiently to enable the directors to carry out the programme which they had sketched out. They had, however, with hard and unremitting work, and with the assistance of the Elmore Foreign and Colonial Company and other leading shareholders, been able to turn out a considerable amount of goods, and had been able to demonstrate most conclusively the manufacturing and commercial value of the process. And, further, they had substantiated every statement that M. Secrétan had ever made as to the quality of the products, the cost of manufacture and the selling prices that could be realised. As, however, their appeal for further subscription of the preference capital was inadequately responded to, they had not been able to maintain the output at the factory on the scale reached in October last (a scale which would have paid all expenses and left a profit), not having money to purchase sufficient supplies of copper, and not being able to see their way sufficiently far ahead to justify them in taking large orders for forward delivery, and consequently such orders had been reluctantly refused. In November the directors informed the shareholders that they had made a contract with substantial persons for placing the £50,000 first mortgage debentures then proposed to be issued. Unfortunately they were misled, and these persons had failed to carry out their agreement, thus placing the company in a position of great difficulty. The money they required had not been forthcoming, and they were about to ask the shareholders to sanction an increase in their borrowing powers, so as to carry out another scheme which had been suggested to them for raising additional working capital, which scheme would be laid before them later on. After pointing out what were the capabilities of the company's magnificent plant at Dives, that they had proved that they could command prices for their products which would yield a handsome profit, and that they had built up a valuable goodwill, the chairman went on to say that they must either raise more capital by some such scheme as they were going to submit, they must sell the company outright, or they must reconstruct. They had received from business men in France, through M. Secrétan, a proposal for the purchase of the company, but some of their leading shareholders thought the terms offered were not sufficiently good to warrant their recommending their acceptance. Those shareholders agreed with the board in thinking it would be much better for all concerned to put their shoulders to the wheel and help, by raising fresh capital, to make the business that success which it could unquestionably be made. They had asked M. Secrétan what sum of money he would require in France to carry on the business and to increase the output to about 20 tons a week. He said that if he were given £30,000 he would, in six weeks' time, be producing and selling this quantity of tubes. This output, though far below what the factory was capable of producing, was sufficient to show a considerable profit, and would demonstrate the financial as well as the commercial success of the process. To raise this money and to provide for their accrued liabilities in England, the following scheme had been proposed:—That they should issue 6 per cent. first mortgage debenture stock to the amount of £100,000, redeemable in five years at £105. That the holders of the existing £50,000 first mortgage debenture stock should exchange their stock either for preference shares or new debenture stock. That their English creditors, nearly all of whom were very friendly and ready to help the company, should take preference shares, as far as possible, in payment of their debts, and that the remainder of the new debentures should be taken up by the present shareholders of the company for cash, thus providing the additional capital required. It was only by some sacrifice on the part of all concerned that they could hope to save the ship, and obviate, if not the loss of everything, a serious loss all round. A large part of the present debenture stock holders had already consented to exchange their stock for preference shares, and those at a meeting recently held approved of the scheme. The chairman concluded by moving "That the directors be empowered to borrow, for the purposes of the company's business, a total amount not exceeding at any time the subscribed capital of the company."

Sir JAMES MACKENZIE seconded the resolution.

M. SECRETAN, after dealing with the present position of affairs, said that if the company were not able to find the necessary funds promised from the beginning, the works would be condemned to inactivity, and other people with more confidence would make a fortune on their ruins. If, on the contrary, their help were forthcoming, this was what they could expect:—With £30,000 paid over to Paris, they would be able in a very short time to produce and sell 75 tons per month, which would give a profit of £11,550 per annum; with £40,000 they could make a profit of £23,400; with £50,000 a profit of £35,250, or with £60,000 a profit of £58,950.

Mr. BODINGTON, the legal adviser of the company in Paris, said he had examined M. Secrétan's order book, and had found that a whole series of orders had been sent in from the largest manufacturing firms in France, from the Government departments, and from the great railways. Numerous letters had been sent in testifying to the highly satisfactory results given by the Elmore copper.

Mr. GLADSTONE: Have you asked any of these people to put £100 into the company? (Laughter.)

Mr. BODINGTON: No.

Mr. GLADSTONE: Do they intend to?

Mr. BODINGTON: They have not expressed any wish to do so.

In reply to Dr. HEDLEY,

Mr. F. RAWSON, a member of the shareholders' committee recently appointed, said he had investigated the statements made by the French Company, and had found that there had been no mis-statements of any material character. One or two anticipations had not been carried out, but that was because they had not had sufficient working capital.

Mr. SAUNDERS enquired what probability there was of obtaining money at 6 per cent., seeing that the proposal to raise capital at 10 per cent. had not been successful.

The CHAIRMAN pointed out that they were now offering debentures with the security of the company's assets, whereas the other issue was only preference shares.

Considerable discussion took place as to the amount of work which had been and could be done at the company's works, after which M. SECRETAN, in answer to Mr. GLADSTONE, said that the process as handed over to him was capable of making, and did make, tubes. He, however, had modified it and added to it so as to make the product such as no other manufacture could compare with.

Mr. SIMPSON (also a member of the committee) quoted figures to

show that the whole of the £325,000 already handed to the directors had been legitimately spent.

After further discussion the resolution was agreed to, and the CHAIRMAN announced that unless the board were able to carry the scheme through the company would be lost.

The proceedings then terminated.

The City and South London Railway Company.

THE half-yearly general meeting of the shareholders of the City and South London Railway Company was held on Wednesday last, at Winchester House, Old Broad Street, E.C., Mr. Charles Grey Mott (the chairman) presiding.

The SECRETARY (Mr. W. F. Knight) having read the notice convening the meeting,

The CHAIRMAN said: It now becomes my duty to move that the report and accounts presented be received and adopted. Although we should have been glad if we had had a larger accession of traffic during the past half-year, and been able to pay a better dividend, still, on the whole, I think you will agree with me that the report shows a very decided and substantial progress, and that the condition of the line altogether is a satisfactory one. During the past half-year we have carried, including the season-ticket holders, some 600,000 more passengers than we did in the same period last year. Since the opening of the line up to the present time we have carried more than 12,000,000 passengers, I am thankful to say, safely and without any accident of any consequence whatever. During the early part of our experience on this line half-year by half-year I have had to deplore that there should have been so many defects in the working, and that our traffic has suffered in consequence from that. It is very satisfactory to feel that during the last half-year we have practically had no stoppages of that kind. I do not know that there is any railway anywhere that could give a better experience of working as to punctuality, regularity, and convenience than can be given by this railway, and considering that this is the first electric railway, and we have only had two years' experience of working it, it augurs very well for the future of similar undertakings. Beyond the fact that we have done fairly well during the last half-year, the company has improved its position financially very considerably. A year ago we had a large amount of Lloyd's bonds and a considerable amount of debts, which pressed heavily upon the board. I am happy to say that to-day in these accounts you will see that those amounts are very largely reduced, and that since the accounts were published we have been enabled practically to pay off every debt that we owed, and we have funds in hand sufficient, if necessary, to pay off every one of the terminable debentures which become due within the next nine months. Therefore, our position financially is an exceedingly strong one. Turning to the capital account of the company, you will see that during the past half-year we have issued preference shares to the amount of £18,560, and we have expended on capital account out of that, £4,456. We have paid off £6,000 of debentures, and we have reduced our debts by £8,000, which accounts for the £18,000 we have raised. We have issued a further amount of preference stock, but we have now issued all the preference stock we intend to issue for some time to come. We gave our existing debenture holders an opportunity of converting their present debentures at par into our permanent 4 per cent. debenture stock before a fixed date, or, if they preferred it, to receive in exchange our 5 per cent. preference stock at par. About a quarter of the amount of our debenture debt was so converted, but the other three quarters has not been converted, and will have to be paid off and dealt with as it becomes due during the current year. Those who took advantage of the offer we made were very wise, because our debenture capital had risen to a considerable premium, and I have no doubt it will go very much higher than it is at present, as it is as secure a stock as you can well have. As we shall be able to issue that debenture stock from time to time at a premium, we shall be able so far to reduce the amount of our debenture interest, and I anticipate that in the future we shall be able to make each half-year, as they fall in, considerable additional savings in interest. With regard to the revenue, which is the most interesting part of an undertaking of this kind, our receipts for passengers during the half-year amount to £21,462, as against £19,550 in the corresponding period of 1891. Our season tickets have brought us in £540, against £249 in 1891; our parcels and other small receipts have brought in £15, against £5 in 1891. Our parcel traffic is slowly augmenting, and we have under consideration the question whether we cannot considerably develop that traffic. Our transfer fees are £9, against £4 last year; our rents are £562, against £435 last year; and our sundry receipts are £64, against no receipts in the corresponding period in 1891, making a total for the half-year of £22,652, against £20,243, or an increase of £2,409 in the half-year. You know that in most railways an increase in the gross receipts does not mean a net increase, as the increase is very often entirely absorbed in working expenses; but I am happy to say it is not so with us. Turning to the expenditure, our maintenance has decreased £101, our locomotive expenditure has increased £148, our carriage repairs have increased £51, our traffic has decreased £317, our general expenses have increased £110, law charges £8, compensation has decreased £26, and rates and taxes remain the same. The result is, that there is a net decrease in expenditure of £127 as against the corresponding period of last year. The result of the half-year is, that we make a profit of £7,262, against £4,727 in the corresponding period of 1891. This, added to the balance brought forward and the bankers' interest, makes an available balance of £8,304, of which the debenture interest absorbs £4,259, leaving £4,045 available for dividend. This will pay 5 per cent. on the preference shares and § per cent. on the ordinary stock, carrying forward a balance of £822, which is within a few pounds the same balance as we carried forward this time last year. I am happy to say that, so far as our experience of the present half-year goes, we show a most satisfactory increase in the traffic. It has averaged an increase of £150 per week since January 1st, and if this traffic increase continues, I hope, when we next meet you, we shall have a much more satisfactory dividend to declare than we have to-day. You may be interested in seeing how far the working of this electric railway promises to be really economical. We have had four complete half-years, and therefore we can form some kind of comparison, and see where we stand. In the first half-year our locomotive expenses—that is, all the expenses which are commonly comprised under the head of locomotive expenses in the ordinary steam railway—were 9d. per train mile; in the next half-year they were reduced to 7·9d., the next half-year to 7·7d., whilst this half-year they were 7·1d. I have mentioned to you those comparisons in order to compare fairly with the locomotive expenses of large steam railways such as the Midland, the Great Western, and the London and North-Western; but you must recollect that in their case they take the price of their coal at the pit's mouth, and they charge no carriage for it. In our case we have to pay the carriage from the pit to London, and, furthermore, we have to pay a heavy cartage into the locomotive depôts. Reducing the price of our coal as it is on an ordinary steam railway—that is, the price at the pit's mouth, without carriage—our locomotive expenses would only have been 5¾d. per train mile, which is a most satisfactory figure as against 9d. on ordinary steam railways; but, of course, our trains are not of such carrying capacity as ordinary trains. At the same time, we have run during the half-year somewhere about 70,000 trains, and we have averaged, including our season ticket holders, about 48 passengers in each train. In the first half-year we averaged 45, in the second half-year 46, in the third 47, and in the last half-year 48 passengers per train mile. But you must remember that this average is considerably less than half the capacity of our trains at present, so that, however big our trains were, we should not gain by increasing the size of them, and therefore, when our expenses are reduced, as I say they would be on the same comparison of 5¾d., we are actually doing as much work as if we had a much larger and more extensive train which was only one-quarter filled. The total percentages of expenditure of working are also interesting. In the first half-year they were 79 per cent. of our receipts, in the second half-year 76 per cent., in the third 70 per cent., and last year they were 67·9 per cent., so, you see, they are coming down very steadily and satisfactorily. Then, again, if you want to compare our percentages of receipts with the percentages of an ordinary railway, you must take out of our expenses all the expenses connected with the lifts, which form no part of the expenses of ordinary railways. In order, therefore, to make a correct comparison with ordinary railways, I have taken out the actual expenses in connection with those lifts, and, after deducting these, our percentage of expenses is only 59½ of the receipts, which is pretty nearly the expenses of our large railways. Some of them are a little lower, but we are rapidly coming down, and I hope that as the traffic increases you will see a very considerable diminution in that figure. During the past half-year we have been running during our busy time additional train service, which has involved us in an average of 1,000 miles a week more, and, therefore, our train mileage has gone up considerably. Of course, we are giving much more accommodation during the busier time of the day, and the result has been that our receipts per train mile have increased. Although we have increased our receipts, our train mileage for the moment has overtaken that. Our receipts per train mile have been 2s. 0½d. during the past half-year, as against 2s. 1d. during the corresponding period of 1891, or ½d. per train less. In the previous half-year in June they were 2s. 2½d., therefore we are 2d per train mile less in our receipts but that is an inevitable consequence when you increase the train mileage, until the traffic increases. Our expenses per train mile, on the other hand, were in the first half-year 1s. 9½d., in the second half-year they were 1s. 7⅞d., in the third half-year they were 1s. 7¼d., and in the past half-year 1s. 5¼d.; so you see our expenses per train mile are going down very satisfactorily. You gave us authority some time since to convert our ordinary share capital into stock. We have availed ourselves during the past half-year of this power, and have converted the 60,000 shares which existed into £600,000 of consolidated ordinary stock, and that conversion has been very largely carried out already. There remain some 3,000 shares to convert, which were issued subsequently upon the authority given to the board, and we propose, at the special meeting to be held at the close of this one, to convert those into consolidated stock, so that the whole of the share capital will be in the form of stock, which is much more convenient for every purpose. The only other point I want to call your attention to is the position of our parliamentary business. You will remember that the Bill of last session, in consequence of the dissolution of Parliament, could not be gone on with in Committee, and was carried over, with several other Bills, to the present Parliament, and it will now be taken up at the point where it left off. I hope and trust that we shall be able to get that Bill, because the rapid increase that is going on in our traffic will, I am afraid, tax our energies to meet it. With reference to the Clapham extension, which we have power to carry out, we propose to get on with a small portion of that undertaking, so as to give some relief in the form of sidings at Stockwell, but we think it will be no use proceeding with that and getting additional capital at present. Until we see some means of dealing with the traffic to the City we think it will be a fruitless expenditure to deal with that matter. We therefore thought it better to leave the Bill in abeyance, and for that purpose we have lodged a small Bill to give us a further extension of time for the purchase of lands, until we know what work we shall have to carry out in connection with the Islington extension. The sidings at Stockwell are very much wanted, and we have signed a contract with a contractor to carry them out, but we have, unfortunately, been met by a good deal of opposition from the

local vestry in the neighbourhood about the question of the right position for sinking a shaft. It will only be there a few months, and we believe we have chosen a spot that is the least inconvenient to the public; but the local authorities have, by their action, not done their best to encourage the accommodation which their own constituents seriously want. We are ready to give them the accommodation they require, but I think we ought to receive from the local authorities every reasonable encouragement in connection with it. However, we have the authority of an Act of Parliament, and we must exercise that authority as far as we can, and we propose to commence those works, and the vestry must take its course. I now beg to move: "That the report and statement of accounts for the half-year ended December 31st, 1892, now presented to the meeting, be received and adopted."

Mr. SAMPSON HANBURY seconded the motion.

Mr. DRAKE congratulated the chairman on the result of the half-year's operations, and also on the improved position of the company. So far as the public was concerned, the line had proved itself to be an absolute necessity.

Mr. MIDDLETON thought the train mileage should be further increased, and that the line should be worked more economically.

The CHAIRMAN, in reply, said that it was useless going on increasing the train mileage if the traffic did not keep pace with it.

The motion was then put and carried unanimously.

After the declaration of a dividend of 5 per cent. per annum on the preference shares, and ⅝ per cent. per annum on the ordinary shares, the retiring directors (Messrs. Charles Seymour Grenfell and Edwin Tate) were re-elected, and Messrs. Turquand, Young, Weise, Bishop and Clarke were reappointed auditors.

The meeting was then declared special, when a resolution was passed authorising the board to convert the existing issued ordinary share capital of the company into consolidated stock.

A vote of thanks was given to the chairman and the board, and the proceedings terminated.

Anglo-American Telegraph Company, Limited.

THE report of the directors reads as follows:—

"The total receipts from July 1st to December 31st, 1892, including the balance of £954 17s. 11d. brought forward from the last account, and a sum of £1,619 16s. 9d. transferred from the interest of renewal fund securities, amounted to £164,365 11s. 3d. This sum, however, is subject to revision, as the lawsuit between this company and the Paris and New York Telegraph Company is still pending before the Court of Appeal. The traffic receipts show a decrease of £4,670 as compared with the corresponding period of last year, but the total for the year 1892 as compared with 1891 shows an increase of £5,365. The total expenses of the half-year, including repair of cables, &c., as shown by the revenue account, amount to £58,628 7s. 6d. Interim dividends of 12s. 6d. per cent. on the ordinary stock and £1 5s. per cent. on the preferred stock, were paid on November 1st last, absorbing £43,750, leaving a balance of £61,987 3s. 9d., out of which the directors recommend the proprietors to declare final dividends of 17s. 6d. per cent. on the ordinary stock, and £1 15s. per cent. on the preferred stock, amounting to £61,250, making a total distribution for the year ended December 31st, 1892, of £2 15s. per cent. on the ordinary stock, and £5 10s. per cent. on the preferred stock, leaving £737 3s. 9d. to be carried forward to the next account. The company's repairing ss. *Minia* has been engaged during the past half-year in the repair of the North and South Placentia cables, and the Duxbury cable. She has also been employed by the Direct United States Cable Company, and the Western Union Telegraph Company for the repair of cables belonging to those companies, the payments for which appear in the revenue account. The Brest-St. Pierre cable was broken on July 14th, and repaired on August 5th by the Telegraph Construction and Maintenance Company's ss. *Britannia*, the ss. *Minia*, not being at the time available to undertake the work, as an entire renewal of her decks had become necessary. The company's cables and land lines are in good working order and condition. The appeal in the proceedings between the Anglo Company and the Paris and New York Telegraph Company, in the Appeal Court of Paris, has not yet been heard. In accordance with the articles of association, two directors of the company, Sir James Anderson and W. S. Cunard, Esq., retire at this meeting, and, being eligible, offer themselves for re-election. Mr. Joshua Dean and Mr. John Gane, F.C.A., the auditors, retire, and offer themselves for re-election."

The ordinary general half-yearly meeting of the above company was held on Friday last at Winchester House, Old Broad Street, E.C. The Marquis of Tweeddale presided,

The Secretary (Mr. T. H. WELLS), having read the notice convening the meeting, also the minutes of the previous meeting,

The CHAIRMAN said that the half-year that closed on December 31st last had been a somewhat disappointing one in respect to traffic receipts; the first half of the year showed an increase of over £10,000, but the last half-year showed a decrease of £4,669. The explanation, of course, was that business had been extremely dull, especially during the last half of the year and that dullness was reflected in their traffic receipts. Competition had been as keen as ever, and had, he was sorry to say, cost them more than ever. This year they would observe under the head of Abstract C, that salaries and wages, agencies and advertising, had cost them very nearly £1,000 more than this time last year. They could not help that, they were obliged to meet competition, and in order to do so satisfactorily and completely they must spend money. They had no reason to suppose that they had suffered in consequence of that active competition more than their rivals; probably, the truth was that they had suffered somewhat less. Happily their repairing ship *Minia* had benefited the revenue account to the extent of £3,000 earned in repairing the Direct and Western Union cables. Their expenses on balance were very considerably lower, the principal items being under the head of working and law expenses; they had expended less by £1,368, while their repairs of cables had cost them £4,123 less than they did at that time last year. Therefore, deducting £113 more from the loss incurred through the fire at Newfoundland, they had a balance of £4,878. They had credited the reserve fund with a sum of £2,021 3s. 2d., being the amount of unclaimed dividends up to December 31st, 1882. That was unquestionably the property of the company and they were entitled to do as they thought fit with it. They had carried that sum to the credit of the renewal fund, as had been suggested at the last meeting. It was not likely that after a lapse of so many years the unclaimed dividend warrants would be presented for payment, but if that should happen they would of course be paid. The renewal fund having for the first time reached a figure in excess of that which the directors had always held should be set aside for renewals of cables, namely £1,000,000, they had decided after careful consideration to carry the amount of £1,619 to the revenue account, or in other words to make that amount available for dividend. That enabled them to recommend a dividend of 30s., against 28s. 6d. in 1891, making a total distribution for the year of £2 15s. per cent. on the ordinary stock. It must not be overlooked that a very large proportion of the capital of the Anglo-American Company was what was called "water;" they might say roughly about half of it. Therefore the dividend really on the actual capital was about 5½ per cent., which, considering that they had £1,000,000 at their credit of reserve fund, could not be taken as a very bad return for their money. The cables were all in good working order and condition. He believed that their system was in a very high state of efficiency, reflecting credit upon all their *employés* upon whose energy, skill and accuracy the success of the company largely depended. The appeal in the French courts made no progress, nor was it likely to do so as long as the company's counsel were engaged on a more profitable business, namely, in attacking the Panama directors. The report or accounts did not call for any further comment; he would only say in addition that they had begun the year fairly well, the increases up to this time were satisfactory, and if they continued during the rest of the year, which was not impossible, and the business became more active, they might look for even better returns than he had been able to submit to them. With those remarks he moved the adoption of the report and accounts, and the declaration of the dividends therein mentioned.

This was seconded by Mr. W. S. ANDREWS.

Several shareholders, Messrs. Davis, Chester, Band, Garner, Griffiths, Newton, Sir Edward Clarke and Sir John Swinburne and others, made some remarks on the question of the £1,000,000 reserve fund, and also regarding the interests of the deferred shareholders.

The CHAIRMAN having answered the questions asked, the resolution was put to the meeting and carried unanimously.

The retiring directors and auditors, as stated in the report, were re-elected, and a vote of thanks to the chairman closed the meeting.

The Direct United States Cable Company, Limited.

THE report of the directors for the six months ended December 31st, 1892, reads as follows:—

"The usual statements of account for the half-year ended December 31st, 1892, are submitted herewith. The half-year's revenue, after deducting out-payments, amounted to £43,629 6s. 1d. as compared with £45.402 0s. 8d. for the corresponding period of 1891, being a difference of £1,772 14s. 7d. against the half-year under review. The working and other expenses for the same period, including income tax, but exclusive of cost of repairs of cables, amounted to £18,982 3s. 7d., leaving a balance of £24,647 2s. 6d. as the net profit, making with £3,730 8s. 1d. brought forward from the previous half-year a total of £28,377 10s. 7d. For the corresponding period of 1891, the working expenses and other payments amounted to £17,672 16s. 5d. Interim dividends of 3s. 6d. per share for the quarter ended September 30th, 1892 (paid October 24th, 1892), and of 3s. 6d. per share for the quarter ended December 31st, 1892 (payable January 28th, 1893), together amounting to £21,248 10s. have been declared, and, after setting aside £4,000 to the reserve fund account, the balance of £3,129 0s. 7d. on the revenue account has been carried forward. During the period under review, repairs have had to be made in both sections of the company's cables at a cost of £6,301 15s. 2d., which has been debited to the reserve fund account as hererofore, the balance of which, with the above addition, stands at £260,298 6s. 1d. A new station has been opened by this company, in conjunction with the Western Union Telegraph Company, at 39, Mark Lane, London, E.C., where additional facilities are afforded both to the cabling public in that locality and to the companies concerned. The new permanent buildings at Ballinskelligs will shortly be completed."

The thirty-first ordinary general meeting of the above company was held at Winchester House, Old Broad Street, on Friday last, 27th ult., Sir JOHN PENDER, G.C.M.G., M.P., presiding.

The SECRETARY having read the notice convening the meeting, also the minutes of the previous meeting,

The CHAIRMAN said that before asking them to pass the report he would, as usual, go over a few of the details of the working of their system during the last six months. The return for the half-year to December 31st last, after deducting outpayments, amounted to £43,629, and the working and other expenses, including income tax

and depreciation of spare cable, to £18,982, leaving a balance of £24,647 as the net profit for the half-year, making, with £3,730 brought forward from the previous half-year, a total of £28,377 which had been appropriated as follows:—Interim dividend of 3s. 6d. per share for the quarter to September 30th, £10,624; interim dividend of 3s. 6d. per share for the quarter to December 31st, £10,624; transferred to reserve fund £4,000, balance carried forward £3,129; total, £28,377. The revenue, as compared with that in the corresponding period of the previous year, shows a reduction of £1,773, but under the circumstances, and looking to the depression existing in many departments of trade, they had, he thought, good reason to be satisfied with the result. The expenses in London showed scarcely any variation in the items, and, on the whole, they were within £5 the same amount as in the corresponding period of 1891. Expenses at station on the other hand showed as follows:—Increases of £122 in salaries, £100 in maintenance, £95 in petties, £126 in rent, fuel and light, and £172 in repairs and renewals, with a reduction of £55 in printing and stationery. The above increases were mostly due to the new receiving station at 39, Mark Lane, and with the further addition of £319 for continental agencies, an item which did not appear in the accounts for 1891, the increase of £1,868 in those station expenses was accounted for on the whole. A saving of £178 is shown in the directors' fees. The expenses in the aggregate showed an apparent increase of £1,391, but it must be pointed out that that included £1,000 written off the acquisition of patent rights account, an item which did not appear in the accounts for the corresponding period, and the real increase was therefore £309 only. Turning to the reserve fund it would be seen that the account was credited with £4,271 for interest on the investments, £3,611 for profit on securities realised, and with the £4,000 transferred from the revenue account, while, on the other hand, £3,671 was debited for cost of repairs, leaving the balance standing at the increased figure of £260,298. The investments now stand at the cost of £234,152, but their present market value was nearly £260,000. That was not an unsatisfactory state of things to put before them, he thought, at a time like the present, when companies were being very much before the public and being very carefully looked into. He would like to give them some idea of the position of their company as compared with the other submarine telegraph companies working in the same seas, namely, the Anglo or the Western Union or the Commercial Company. The Direct United Company at the present moment, if they took into account the dividends and the value of the property in the market, was paying probably the highest rate of interest of any of the other companies. They were paying practically 5⅞ against the Anglo Company's 5, and against the Western Union Company's 5½, and against the Commercial 3¹⁵⁄₁₆. The Commercial Company occupied the peculiar position of being at a large premium, while the other companies were at a very large discount. The directors of the Direct Company were watching very closely the working of the system; they were carrying their proportion of the traffic well and accurately, and they had just opened a new office in Mark Lane which, if the shareholders would call in and see, they would find it a place which looked as if it belonged to a thriving concern. In the papers from time to time they would observe that their work was recognised as not being, at least, inferior to any others, it was in some respects perhaps better, so that altogether they had no reason to feel other than pleased at the position that they occupied among the other cable companies. After some further remarks on the general working of the system, he moved "that the report of the directors dated January 13th, 1893, together with the statement of accounts to December 31st, 1892, annexed thereto, be and the same are hereby received and adopted."

Mr. E. M. UNDERDOWN, Q.C., seconded the resolution, which was unanimously carried.

A vote of thanks to the chairman and directors, which was acknowledged by the chairman, who, at the same time, answered two questions which had been asked by shareholders, closed the meeting.

Portrush, Giant's Causeway, and Bush Valley Tramway Company.

THE seventeenth half-yearly meeting of the directors and shareholders of the Portrush, Giant's Causeway, and Bush Valley Railway and Tramway Company was held in the company's offices, Portrush, on Saturday last. Dr. Anthony Traill, J.P., F.T.C.D. (chairman), presided.

The report was unanimously adopted, as follows:—Your directors beg to submit for the approval of the shareholders their annual report to December 31st, 1892, which completes the tenth year since the line was opened for traffic. Your directors have to report a diminution in the receipts under every head during the past year as compared with those of the year 1891, though the total is still in excess of that of the year 1890. In the passenger traffic there has been a falling off in the numbers to the extent of 1,591 first-class and 5,137 third-class passengers, making a total of 84,970, compared with 91,698 in 1891 and 82,802 in 1890. The receipts have consequently fallen to £2,263 0s. 5d., as compared with £2,830 4s. 2d. in 1891, and £2,579 19s. 5d. in 1890. The goods and mineral traffic fell to 36 tons, from 181 tons in 1891, and 316 tons in 1890, while the receipts under this head have fallen from £29 1s. 5d. to £17 7s. during the year. As this traffic was a serious cause of loss in past years, this diminution is not to be regretted. The miscellaneous receipts and those for parcels have diminished from £31 0s. 9d. to £24 8s. 6d., so that the total receipts from revenue account have been £2,704 15s. 11d., as against £2,895 14s. 7d. in 1891, and £2,698 15s. 4d. in 1890. On the other hand, there has been a considerable reduction on the expenditure side of the account, which shows a total £1,720 18s. 10d., as against £1,945 6s. 6d. in 1891, and £1,687 12s. in 1890. There is, consequently, a credit balance on the result of the year's working of £983 17s. 1d., as against £950 8s. 1d. in 1891, and £1,011 3s. 4d. in 1890. The past year has, therefore, fully maintained the successful turn in the state of the finances of the company which took place in 1890 and 1891, the corresponding credit in 1889 having been only £381 18s. 7d. It will be seen on an examination of the above figures that the ratio of expenses to receipts has been 63½ per cent. during the past year, while that ratio was 67 per cent. in 1891, 62 per cent. in 1890, and 82 per cent. in 1889, while the number of miles run by steam power during the year has only been reduced from 12,280 to 12,002, the cost remaining at 1s. per mile. Those run by electrical power have fallen from 19,863 to 14,007, raising the cost from 4d. to 5d. per mile. This diminution of 6,134 in the total number of miles run corresponds with the diminution of 6,728 in the number of passengers carried during the year, but the cheapness of electricity as a locomotive power is still strikingly illustrated by the above figures. Your directors regret to have to report that during the past year an action for compensation was brought against the company for injuries caused in the year 1891 to a lady who threw herself off one of the cars, through fright at a collision which seemed to be impending between a steam engine and an electric car coming in opposite directions on the line, though no collision beyond the slightest contact actually occurred. Juries seem to think that companies have unlimited resources, and that they must be in fault, no matter how careless passengers may be, and consequently a verdict was given at Londonderry against the company for £375 with costs, amounting altogether to about £500. This sum your directors have been absolutely unable to pay, as the prior charges for interest on money borrowed for the construction and equipment of the line practically consume the balance from the year's revenue account, which accumulated to over £1,600 in the first eight years of the existence of the company, have only been reduced to £1,579 12s. 10d. in 1890, £1,569 2s. 8d. in 1891, and finally to £1,518 9s. 5d. during the past year. In the meantime, however, the property of the company is protected by the bill of sale to the Board of Works, which has been renewed every five years since the original loan of £10,000 was advanced to the company. In conclusion, your directors have often had to remark in previous reports how much the success of the line depends on the general state of the country, prosperity being accompanied by a rise and depression by a fall in the receipts. The slight fall in the receipts during the past year has, however, arisen from a single anomalous cause, which, fortunately, does not recur save at intervals. The general election seriously interfered with the passenger traffic in the end of June and in the beginning of July, not only in the way of tourists and travellers to the Giant's Causeway, but in the way of summer residents in Portrush, who largely patronise the line during the period of their stay. Many families throughout the country postponed leaving home and making their arrangements for the summer until after the general election, and the loss in the receipts of the company took place almost entirely during that period, which, in general, is one of considerable value to the company. From the reduction, however, which your directors were enabled to make in the working expenses, this loss has been more than counterbalanced, and the net result of the year has, on the whole, been satisfactory, though no dividend can yet be announced. Mr. James Stewart-Moore is the director who retires by rotation, and he is eligible for re-election.

Mr. James Stewart-Moore was unanimously re-elected a director of the company.

A vote of thanks was cordially passed to the chairman and the other directors for their attention to the interests of the company during the half-year.

The CHAIRMAN having acknowledged the compliment, the proceedings terminated.

General Electric Power and Traction Company, Limited.—The annual general meeting of this company, adjourned in December owing to the accounts not being ready, was to have taken place last Tuesday at Winchester House. The chairman of the company, Lord Albemarle, being seriously ill, and Lord Egerton and other directors being absent on the Continent, also through illness, the meeting was again adjourned until February 14th. Mr. James Pender, who occupied the chair, said it was hoped that the report and accounts would be forwarded to the shareholders on Friday. In answer to questions put by shareholders, Mr. Pender stated that the items in the profit and loss account would be shown in detail, and that Mr. Paxman resigned his seat on the board because other business prevented his attending the meetings. The meeting was then adjourned.

Submarine Cables Trusts.—It is notified that on and after February 7th the sum of £1 10s. (being the balance of the coupon due October 15th last) will be paid by Messrs. Glyn, Mills, Currie & Co.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending January 29th, 1893, amounted to £976; week ending January 31st, 1892, £823; increase £153; total receipts for half-year, 1893, £3,954; corresponding period, 1892, £3,328; increase £626.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending January 27th, after deducting 17 per cent of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,648.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.	Closing Quotation, January 26th.	Closing Quotation February 2nd.	Business done during week ended February 2nd, 1893. Highest.	Lowest.
195,100*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 — 103	100 —103	...	...
1,247,720*l*	Anglo-American Telegraph, Limited	Stock	54½ — 55½	53½ — 54½	55¼	54
2,876,140*l*	Do. do. 6 p. c. Preferred	Stock	96⅛ — 97⅛	95½ — 96½	97¼	96
2,876,140*l*	Do. do. Deferred	Stock	13¼ — 13⅜	12¼ — 12⅜	13 9/16	12 1/16
130,000	Brazilian Submarine Telegraph, Limited	10	11 — 11½	11¼ — 11⅜	11½	11¼
34,600*l*	Do. do. 5 p. c. Bonds	100	101 —104	99 —102 xd	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	104 —118	104 —108	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3¼ — 3⅜	3⅛ — 3⅜	3⅜	3 3/16
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅜ — 2⅝	2⅜ — 2⅝	2½	2⅜
125,000*l*	Do. do. 4½ per cent. Debenture Stock	Stock	103 —105	103 —105	104⅛	104⅜
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3 — 4	3 — 4	...	...
600,000*l*	City and South London Railway	Stock	35 — 38	37 — 39	37½	...
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	11⅜ — 12¼	11⅜ — 12¼	12⅛	11⅞
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000	10	7⅞ — 8¼	7⅞ — 8¼	8⅛	8
$7,716,000	Commercial Cable, Capital Stock	$100	175 — 180	175 —180	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	3/16 — 5/16	3/16 — 5/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5 — 5½	5 — 5½	5⅜	...
16,000	Cuba Telegraph, Limited	10	12 — 13	12 — 13	...	...
6,000	Do. do. 10 p. c. Preference	10	17½ — 18½	18 — 19	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	2 — 3	2 — 3	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	11⅜ — 12	11⅜ — 11⅞xd	11 13/16	11 11/16
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅞ — 15	14⅞ — 15	15	14 13/16
70,000	Do. 6 p. c. Preference	10	16 — 17	15½ — 16½	16 3/16	16
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	108 —111	106 —109 xd	109	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	111 —114	111 —114	113	112
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14⅞ — 15⅛	14⅞ — 15⅛	15⅛	15
70,600*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	102 —105	103 —106	...	...
250,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	102 —105	103 —106	104½	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	111 —114	109 —112 xd	...	...
122,400*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	102 —105	102 —105	104½	...
163,700*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	102 —105	102 —105	...	...
300,000*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	103 —106	101 —104 xd	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	2¼ — 2⅜	2¼ — 2⅜	2⅜	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	⅛ — ¼	⅛ — ¼	1/16	...
82,395	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	⅜ — ⅝	⅜ — ⅝	...	...
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	⅜ — ½	¼ — ½	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅜ — 10	9⅜ — 10	9 15/16	9 13/16
180,042	Do. do. 6 p. c. Preference	10	15 — 15¼	15 — 15¼	15 3/16	15
150,000	Great Northern Tel. Company of Copenhagen	10	18⅜ — 19¼	18⅞ —19½	18⅝	...
210,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	106	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 466*l* to 14,000 ...	10	4½ — 5½	1½ — 5½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	8 — 9	6½ — 7½	...	...
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	22 — 23	22½ — 23½	23½	23
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	102 —104	103 —105	103½	...
17,000	Indo-European Telegraph, Limited	25	44 — 46	43 — 45	44½	43½
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	2½ — 3½	2½ — 3½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	6 — 7	6 — 7	...	...
30,000	†Liverpool Electric Supply, £3 10s. paid	5	3⅝ — 3¾	4 — 4¼	4⅛	4 1/16
10,000	Do. do. fully paid	5	5¼ — 5½	5⅜ — 6	6	...
38,348	London Platino-Brazilian Telegraph, Limited	10	4 — 6	4 — 6	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	108 —111	108 —111	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	6¾ — 7¼	6½ — 7	6⅞	6⅝
50,000*l*	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	102 —105	102 —105	...	...
454,747	National Telephone, Limited, Nos. 1. to 438,984	5	4⅞ — 5⅛	5⅛ — 5⅜	5 7/16	4 13/16
15,000	Do. 6 p. c. Cum., 1st Preference	10	14 — 15	14½ — 15½	14 13/16	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	13¾ — 14½	13¾ — 14½	14⅛	14
90,950	Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ...	5	4¼ — 4½	4¼ — 4½	...	...
726,477*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	112 —115	112 —115	114¼	113½
48,800*l*	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	... ...	... ...	...	...
6,318	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	5 — 6	5½ — 6½	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	⅛ — ¼	⅛ — ¼	...	...
11,802	Reuter's Limited	8	7½ — 8½	7½ — 8½	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	7¾ — 8¼	7¾ — 8¼xd	8⅛	7 13/16
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	8¼ — 8¾	8 — 8¼xd	8 5/16	...
3,381	Submarine Cables Trust	Cert.	120 —125	120 —125	124	120½
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	3 — 3½	3 — 3½	...	...
37,350	Telegraph Construction and Maintenance, Limited	12	45 — 47	45 — 47	46½	45¾
150,000*l*	Do do. do. 5 p. c. Bonds, red. 1894	100	101 —104	101 —104	...	...
58,000	United River Plate Telephone, Limited	5	2½ — 3	2½ — 3	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	90 — 100	90 —100	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	6½ — 7½	6½ — 7½	...	...
260,900*l*	Do. do. do. 5 p. c. Debentures	100	101 —104	102 —105	104	...
30,000	West Coast of America Telegraph, Limited	10	2½ — 3½	2½ — 3½	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	101 —105	101 —105	...	...
64,242	Western and Brazilian Telegraph, Limited	15	7¾ — 8¼	7¾ — 8¼	8 1/16	...
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	5¾ — 6¼	5¾ — 6¼	6¼	6
33,129	Do. do. do. 5 p. c. Deferred	7½	1¾ — 2¼	1¾ — 2¼	2 3/16	2 1/16
184,100*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	107 —110	104 —107 xd	...	...
230,100*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	107 —110	104 —107 xd	109	106¾
88,321	West India and Panama Telegraph, Limited	10	1½ — 1⅝	1½ — 1⅝	1 11/16	1 9/16
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10½ — 11	10½ — 11	10¾	...
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8½ — 9½	8½ — 9½	...	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	105 —108	105 —108	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 —125	120 —125	...	...
171,000*l*	Do. do. 6 p. c. Sterling Bonds	100	103 —106	103 —106	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5⅜ — 6¼	5⅜ — 6¼	6	5¾

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange. Bank rate of discount, 2½ per cent. (January 26th, 1893.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6¼ paid), 7¼—7⅜.—Brush Company 4½ per cent. Debenture stock, issued at 1 per cent. premium, 100—103.—Electric and General Investment, shares of £5 (£1 paid), 1¾—2¼xd.—Founders' shares, 200—225.—Electric Construction Corporation, 6 per cent. Debentures, 95—98.—Electricity Supply Corporation, Ordinary of £5, 5—5½.—Elmore Foreign and Colonial Copper, Founders shares, 6¼—7½.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20½.—Founders' shares, 10—20.—Halifax and Bermuda Cable 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 1½—2½.—Do. 7 per cent. Preference of £5, 5—5½.—Do. 6 per cent. Debentures of £100, 97—102.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5—5½, 1st Preference Cumulative 6 per cent., £5 (fully paid), 6—6¼.—Liverpool Electric Supply Shares of £5 (fully paid), 5¼—5¾.—Manchester, Edison and Swan Company, £9 (£1 paid), ¼—⅜.—Queen Anne's Mansions Lighting and Heating, Debentures, 101—103.—Woodhouse and Rawson £5 Preference (fully paid), ¾—1¼.

REVIEWS.

Electrical Experiments: A Manual of Instructive Amusement. By C. E. BONNEY. London: Whittaker & Co., Paternoster Square, E.C.

This is an excellent book for boys, and even for those of a more advanced age. The author suggests that scientific clubs might be formed in villages so as to afford instruction as well as amusement for leisure hours, and the experiments described in the book show on what lines this idea might be carried out. The work is divided into over 60 sections, dealing with a great variety of electrical subjects, and describes a very large number of experiments. In the first portion of the book magnetism is dealt with. Some of the references in this case are rather meaningless, such, for instance, as when the author says "The Morse sounder, which has worked a complete revolution in telegraphy since its introduction, *is* (the italics are our own) also an electro-magnet;" "a complete revolution" is, to say the least, rather a far-fetched statement. In the chapter on "Experiments with induction coils," we are told "If the wire helix is wound over a core and doubled on itself so as to form a double helix, and many folds of a much finer wire is wound over this, a current of very high tension is induced in the second wire, and a coil thus constructed is named an induction coil;" this would lead one to suppose that an essential feature in the primary of an induction coil is that the "helix should be doubled on itself." There are, unfortunately, many instances of careless writing of this kind in the book, which materially reduces its usefulness. As to the illustrations, the less said about them the better; a large number apparently have been scribbled by the office boy on a piece of blotting paper, and then reproduced exactly. But with all its defects the work has considerable merit, and should be of use to those for whom it is written.

Telegraphic Connections, embracing Recent Methods in Quadruplex Telegraphy. By CHARLES THOM and WILLIS H. JONES. London: E. & F. N. Spon, 125, Strand.

This work is purely an American one, and of very little interest to English readers. It describes quadruplex telegraphy as used in America, and in America only. The letterpress is good, and the twenty full-page plates which illustrate the connections, most excellent. Those who are interested in the subject will do well to purchase a copy of the book, but we fear that there will be but a very small demand for the work on this side of the Atlantic.

Journal of the Institution of Electrical Engineers. No. 101. London: E. & F. N. Spon, 125, Strand.

The general contents of this number are as follows:—Discussion on Mr. Swinburne's paper on "The Problems of Commercial Electrolysis;" "Experimental Researches on Alternate Current Transformers," by J. A. Fleming, F.R.S.

How to Manage the Dynamo. By S. R. BOTTONE. London: Whittaker & Co., Paternoster Square, E.C.

This is a small book of less than 50 pages, and professes to be a "Handbook for ship engineers, electric light engineers, and electroplaters." No attempt is made to explain the theoretical or constructional details of dynamos, but the proper way of setting up the latter and the general management of the same are very clearly explained. To an engineer who may be suddenly called upon to undertake the management of a dynamo the book should prove extremely useful. The matter is unpretentious and very much to the point; altogether it has impressed us very favourably.

Handbook of Electrical Testing. Fifth edition. By H. R. KEMPE. London: E. & F. N. Spon, 125, Strand.

The universal popularity of this book is, perhaps, the best proof of its usefulness. So widely has it been adopted that there is probably no testing-room which does not possess a copy. The fifth edition, which is now issued, comes in a different guise to its sombre predecessors. The characteristic dusky-olive covers are replaced by a more electric blue. Its dimensions are extended in the direction of its length, but there is little lost in thickness, and nothing, unfortunately, in weight. It consists of the former edition revised, to which is added about ten per cent. of new matter.

The "automatic" electrician has long grumbled that this work is too full of, what he considers to be, superfluous mathematics; he does not mind an empirical formula provided it is terse and easily digested. Here and there, it must be confessed, the proofs do seem unnecessarily long; and again, here and there, they might be simplified; yet, in problems where the "limits of accuracy" and the "best conditions for making the test" are to be calculated, the whole proposition must be distinctly stated, or the results will be valueless. Everybody who has used the book practically, has learnt to appreciate these "best conditions," they form one of the most useful features of Mr. Kempe's work, and counterbalance the additional stolidity. Those who complain in this regard should make their own note-books, diluted from the greater work and sweetened with the record of experiments and experiences.

Amongst other new matter, the theory of the ballistic galvanometer and of the damping effect of air on the swing of the needle are fully discussed, a feature which we do not recollect having seen in other works.

The remarks as to the care of instruments are, for the most part, excellent, but there is one of Mr. Kempe's "precautions" which it might be well to placard "dangerous." It is where the advice is given to scrape the plugs of resistance boxes with glass or emery-paper. A method which the present writer has found to be far less risky is to drill a hole the size of the plug in a piece of soft wood; a few twists of the brass plug in this hole, with perhaps a little rouge, will generally suffice to do all that is required. Similarly, a plug of wood has been found useful for brightening the holes between the brass blocks. Again, where the fixing of galvanometer fibres is described, Mr. Kempe condemns shellac and shellac-varnish for fixing the knots in the silk. Is it quite clear why they should not be so attached? If the torsion of the fibre has any appreciable value the attachments should be as definite as possible at the two ends. A knot with a loop is less rigid than a stuck-on arrangement. A loop follows round with the fibre to some extent, and the torsion does not begin to count at once. Further, there seems rather a misunderstanding as to the setting-up of galvanometers. Mr. Kempe says: "At all cable works the instrument is placed on a solid brick table built on the earth so that no vibration can possibly affect it." In this he is a little mistaken, for in some cable works the galvanometers are not put upon tables at all, but are suspended by four india-rubber tubes, one from each top corner. The tubes are about 3 feet long, and the controlling magnet is on a separate bracket, a plan which has been adopted for the reason that foundations cannot always be relied upon for solidity.

In former editions of this book it was stated that the "false-zero" method of measuring by the bridge requires that a resistance, equal to that of the battery, be substituted for the battery at the moment of trial; and a special key was used for the purpose. It is interesting to find this an unnecessary complication, it was first shown to be so by M. Emile Lacoine.

With some of the descriptions of tests, more practical details would be of the greatest service. For instance, in the Thomson method of measuring galvanometer resistance, instructions to use an adjustable shunt for the battery would save a beginner a great deal of alarm, and might rescue the galvanometer from destruction. If the test were carried out as it stands described, a sensitive galvanometer would probably run wild at the first tap of the key. Another galvanometer might be rescued on page 312, 6th line. The reader is told to short-circuit a condenser and then depress a key. For the sake of literal readers it might be wise to direct that the condenser-plug be removed before closing the battery circuit. And for the benefit of the same gentlemen it would be well to add "at the fault," after the curious statement on page 257, that a positive current applied to a cable "coats the conductor with chloride of copper."

The formula of Gott's test is right way up at last. There is, however, still a slight relic of the error of the former work. At page 352 the preliminary direction is to adjust R_1 and R_2 as nearly as can be estimated in the proportion of F_1 to F_2. Of course it should be as F_2 to F_1. By the way, there is an "f" undefined at p. 69; perhaps it is too evi-

dently an acceleration to need comment. The value given for n at the bottom of p. 363 is slightly wrong in sign, owing to a misprint; it should be written:

$$n = \frac{\cdot 5552372}{\log\left(\frac{F_1 + F_2}{F_1}\right)}$$

For practical purposes there is no reason why this should not be simplified. Dividing through by ·4343, we have

$$n = \frac{1\cdot 278}{\log_\epsilon\left(1 + \frac{F_2}{F_1}\right)}$$

The expansion of this denominator will be $\left(\frac{F_2}{F_1}\right)$ plus terms involving squares and higher powers of $\left(\frac{F_2}{F_1}\right)$. But since F_1 is, in practice, considerably greater than F_2, all terms after the first may be neglected, and there will still be a sufficiently near approximation. So that

$$n = 1\cdot 278 \frac{F_1}{F_2}$$

For tests, where $F_2 = 1$, which is often the case,

$$n = 1\cdot 278\ F_1.$$

A Pocket-book of Electrical Rules and Tables. By J. MUNRO and A. JAMIESON. Ninth Edition. London: Charles Griffin & Co., 12, Exeter Street, Strand.

The few extra pages which have been added to the new edition of this pocket-book, chiefly comprise Lord Kelvin's multicellular voltmeter capacity test; Muirhead's correction for Thomson's capacity test; the Board of Trade instructions for setting up Clark's standard cell; also contributions by Dr. Sumpner, Mr. J. Swinburne, Mr. C. V. Luke and Mr. Allen.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

An ordinary general meeting of the Institution was held on Thursday Evening, January 26th, Prof. W. E. AYRTON, F.R.S., Past-President, in the chair.

The minutes of the last ordinary general meeting having been read and approved, the chairman presented the various premiums as follows:—The Institution premium, value £10, to Mr. Nikola Tesla; the Paris electrical exhibition premium, value £5, to Mr. Anthony Reckenzaun; the Fahie premium, value £5, to Mr. A. W. Heaviside and Mr. R. C. Jackson.

The thanks of the Institution to Professor Ayrton for his conduct in the chair as president during the past year, having been proposed by Mr. A. Siemens and seconded by Professor G. Forbes and carried unanimously, the President-elect, Mr. W. H. Preece, F.R.S., then read his inaugural address, of which the following is an abstract:—

I.—TELEGRAPHY.

Having completed my fortieth year of continuous service in developing the practical applications of electricity for the use and convenience of man, it has appeared to me that I could not better repay the high compliment you have conferred on me by electing me, for the second time, to be your President, than by surveying and criticising the growth of the various branches of electrical industry with which I have been more or less associated during this long period.

In 1852, when I commenced my engineering career in the office of Mr. Edwin Clark, member of the Institution of Civil Engineers, the electric telegraph was in its infancy, the principal instrument used in England was the double needle. It required two wires for its operation. This wonderful structure is now discovered only in our museums.

The semaphore has also been relegated to the museum, and the Morse recorder is gradually disappearing to the same refuge, the ear is more accurate than the eye, and more rapid in deciphering those fleeting signals that convey language.

The record, however, remains in Wheatstone's automatic apparatus and in Prof. Hughes's beautiful typewriter, an instrument which is now the great international medium of communication between all European nations.

The instrument that we have principally developed in England is the automatic fast-speed apparatus, based on a principle of preparing messages for transmission by punching, devised by Alexander Bain in 1848, and improved in its mechanical details by Mr. Augustus Stroh in 1866.

This has been my special pet, and through the electrical assistance of Mr. J. B. Chapman, and the mechanical skill of Mr. J. W. Willmot, the practical speed of working has been multiplied more than six-fold, so that 75 words per minute have become 500; a possible 130 has become an actual 600. Duplex automatic working over cable lines is possible, and modes of working have been introduced that were thought at one time chimerical and impossible.

All these things have been done without recourse to the Patent Office. Dozens of improvements have been effected which in ordinary commercial life would have been patented and published, and received recognition. The absence of a patent has led to the belief in the absence of invention. An actual six-fold capacity for carrying messages is an answer to this supposition.

The Hughes typewriter has this year been successfully duplexed between London and the Continent, a problem which had hitherto baffled all attempts at a satisfactory solution.

The employment of copper as the conductor suspended on poles in place of iron, which was inaugurated at my instigation in 1884, by a very costly experiment between London and Newcastle, has had a material influence in increasing the speed of working and improving telegraphy.

This is due not only to its reduced resistance, but to the absence of electro-magnetic inertia in a long, single-suspended copper wire. All our long important telegraphic circuits are now built with copper.

One of the arguments used against the proposed transfer of the telegraphs to the State was the notion that invention would not be fostered by a Government department. This has been entirely falsified. Telegraphy has been advanced in this country more rapidly by the British Post Office than by any private undertaking, and we have certainly shot ahead of our smart cousins on the other side of the Atlantic, from whom, however, I am proud to say, I learnt so much on my visits in 1877 and 1884. Their engineers are looking to us to develop their inventions, and we have done so. They cannot always get them taken up in the States. Diplex, quadruplex, and multiplex telegraphy are importations from them, but they have been improved in our service by our own developments, and have now become the staple and the standard modes of working. No one has done more to effect this object than Mr. M. Cooper.

An accident in the drafting of the Act of Parliament of 1868-69 transferring the telegraphs from the hands of private companies to that of the State, has led to a tremendous development of newspaper reporting in England. The growth of Press messages is shown in the fact that 21,701,968 words paid for in 1871 have grown in 1891 to 600,409,000—an average of nearly 2,000,000 words per day.

The Exchange Telegraph Company, which commenced operations in 1872, working under the license of the Postmaster-General, has in London over 800 instruments at work (120 being in newspaper offices), distributing a daily average of 3,381,134 words to various receiving instruments, adapted to the requirements of the respective services. The financial intelligence, for example, being transmitted over instruments furnished with type-wheels containing the various fractions most in use in Stock Exchange quotations. The latest form of this instrument prints at the rate of 40 words per minute. General and Parliamentary intelligence are distributed to the clubs over column printers, and legal, sporting, and Parliamentary news to newspapers on specially fast tape printers, capable of delivering, in the hands of skilled operators, 45 full words per minute to any number of subscribers simultaneously. The news transmitted is chiefly commercial and financial, amounting to 2,775,000 words per day.

Some idea of the growth of the general telegraphic business of the country may be gathered from the following statement, which gives the total number of messages paid for in each year:—

1852	211,137
1869	6,830,000
Transfer took place in 1870.	
1882	31,345,861
1892	70,215,439

II.—SUBMARINE TELEGRAPHY.

The growth of submarine cables about the world is extraordinary. The total mileage, which in 1852 was 87 nautical miles (nauts),* now reaches a total of 139,594 nauts, of which 14,479 nauts belong to various Government administrations. There are now 11 cables bridging the Atlantic Ocean.

Between this country and the continent all the cables (with the exception of those to Norway, those to Spain, and those forming the connections with the Eastern Telegraph Company's system) now belong to the respective government administrations, and are all maintained by them.

The British Post Office owns and maintains those to Holland and one of those to Germany, while those to Belgium and France, containing 37 wires, are joint property, but maintained by the British Post Office.

By far the greatest cable corporation in the world is the Eastern Telegraph Company, the mileage of whose system is 25,376.

The form of cable has practically remained unaltered since the original Calais cable was laid in 1851. India-rubber is creeping in, owing to the high price and scarcity of gutta-percha.

Next to strong tides, rocky bottoms, anchors, and shallow water, the greatest enemy to submarine cables, more especially in the tropics, has proved to be the teredo of various species; but this depredatory worm has been utterly routed by covering the gutta-percha core with

* It is a very general custom to spell this abbreviated term for a nautical mile *knot*, but a knot is a velocity, not a length. It is a nautical mile per hour.

a lapping of thin brass tape laid on spirally. A remarkable thing about this little insect is that, whereas 20 years ago it was practically unknown in our English waters, it has now gradually spread all round our coasts, with the exception, perhaps, of the North Sea. A new cable about to connect Scotland and Ireland is being served with brass tape.

Perhaps the most remarkable history of a cable is the following:—In 1859 the light cables laid in 1853 from Orfordness to Holland were picked up and replaced by a heavier one. A few nauts were sold to the Isle of Man Telegraph Company, and had an extra sheath laid on. This cable was submerged between that island and St. Becs, where it remained until 1885, when it was replaced by a three-core cable. It was again put under water in 1886 as part of the cable between Uist and Harris, in the Hebrides, where it still lies, as good as ever. The durability of submarine cables is remarkable. That laid between Beachy Head and Dieppe in 1861 is still working; and that laid between Beachy Head and Havre in 1870 has broken within the last month for the *first* time.

Despite the enormous growth of submarine cables during these 42 years, there would appear to be plenty of scope for still further extension. The Pacific still remains untouched, and a project is at the present time under consideration to connect our possessions in North America with those in Australia.

III.—Lightning Protection.

There is no more perfect apparatus in existence than the lightning protector; in 1892 not one single accident was recorded to any high-class telegraph instrument in the whole of the United Kingdom. Prof. Oliver Lodge has, with characteristic energy, endeavoured to modify our views as to the behaviour of lightning discharges and as to the form of protectors, but without much success. His views have not received general acceptance, for they are contrary to fact and to experience.

IV.—Railway Signalling.

In 1861-62 I developed on the London and South Western Railway the system which is known by my name. The characteristic of this system is the assimilation of the outdoor to the indoor signals, thus placing in the hands of the signalman a counterpart of the signals worked by him for the guidance of the engine-driver—the same semaphore signals, the same kind of interlocking switches, and the same mode of working. Walker and Tyer worked in the same field; while Mr. Spagnoletti sought a similar result by employing, in the place of the indications of the needle, a movable flag inscribed "Line clear," "Line blocked."

Great as are the advantages of the block system, as it is popularly known, there is yet room for improvement. Over thousands of miles of railway the electrical signals are worked independent of the mechanical signals. It is possible to operate the one without the other. The desirability of welding the two together, so as to render them perfectly homogeneous in their action, was recognised by me as early as 1870, when what I believe to be the first interlocking of the electrical with the mechanical signals was effected at Southhampton, and subsequently at Wimbledon and Kew, on the London and South Western Railway. In 1875-77 the combination was most effectually completed by Mr. Sykes, who has now brought his system to great perfection. He was followed, in 1877-78, by Saxby and Farmer, under Hodgson's patent; and later still by Mr. Langdon on the Midland Railway, and by others. It now only remains for the railway companies to apply such of these inventions as may be most suitable to their system, in order to place block working upon a perfectly sound basis.

The latest application in this now extensive industry is Tyer's train tablet system, produced in 1878; together with that of the electrical train staff, devised and elaborated by Messrs. Webb and Thompson, of the London and North Western Railway, in 1889. Both systems tend towards the modification of the difficulties, as well as the cost, attending the working of single lines of railway.

V.—Telephony.

The fewness of the actual improvements on the Bell receiver and the Hughes microphone is scarcely more astonishing than the immense number of fruitless attempts at improvement that have been made. Even now the original instruments are not easily beaten.

The institution of telephone exchanges has led to a development of systems of switching that might fairly be considered a special study in themselves, and the demand for communication between distant places has necessitated the application of much special attention to the method of constructing lines and of arranging circuits.

It is in this latter field that I have been a diligent worker, and the application of the so-called "K R" law has proved of material benefit in connection with the problems of long-distance telephony. It is a law which implies that the number of signals that can be transmitted per second through any circuit depends solely on the capacity (K) and the resistance (R) of the circuit. It is very much the fashion to deny the accuracy of the K R law. This is probably the result of ignorance of its meaning or of its interpretation. Some speak of it as empirical, others scoff at it as imaginary, and some sneer at it as an impossible law; but it is a law that has determined the dimensions and speed of working of all our long submarine cables; it determines the number of arms a circuit can carry on the multiplex system, the speed attainable with the Wheatstone system, and the distance to which it is possible to work quadruplex; it is a law that has enabled us to bring London and Paris within clear telephone speech of each other, and which will probably before the year is out enable Dublin and Belfast to speak to London—a message of peace to Ireland as solid and substantial as any promised political proposal.

The New York and Chicago trunk line is 950 miles long, and it is built with 435 lbs. (or No. 8 S.W.G.) copper wire. This wire gives a resistance of 2·06 ohms per mile, which is easily verified; but it is said by Mr. Wetzler to have a capacity of 0·0158 microfarad per mile, which cannot be verified, and which is absurdly high. 0·0158 microfarad was a measurement made by me in England on an old line, but I have frequently pointed out that owing to the use of earth wires the capacity of our English lines is very much greater than that of American lines. Mr. Edison discovered this in 1872 when he came to England to introduce his automatic system. Moreover, I have also pointed out that induction still further diminishes this capacity. The Paris circuit does not exceed 0·005 microfarad per mile. I should estimate the Chicago circuit at 0·004 microfarad per mile, and the K R at 7,500, which gives a result that quite accords with the opinions that I have heard expressed by those who have tried the two circuits as to the relative efficiency of the Paris and Chicago lines. My American friends would have done better if they had used thicker wire. I should have specified 600 lbs. per mile; but if it had been in England I should have used 1,000 lbs., for we cannot dispense entirely with cables and underground work as they have done in the States, and the increased capacity introduced must be compensated for by reduced resistance. As a matter of fact, I once proposed 1,200 lbs. wire for a circuit between London and Berlin—a distance of 760 miles, including a cable 55 miles long.

The beneficial effect of induction as a negative capacity is observed when working a circuit telegraphically with automatic high-speed apparatus. Thus, on two copper wires 450 miles long, making 900 miles altogether, the speed on each single wire was 120 words per minute, and on metallic circuit

Loop *via* different routes	...	...	120	words per minute.
„ on same poles	...	...	150	„ „

So that the improvement effected by induction was 25 per cent.

There is no difficulty in measuring R of a metallic loop. The Wheatstone bridge determines it at once. There is more difficulty in obtaining K. It cannot be measured directly. But with a metallic loop of copper, partly overhead and partly underground, there are several modifications required, due to electrostatic and electro-magnetic induction, which are at present beyond the reach of formulæ, and render it difficult to determine the capacity except approximately from the telephonic effects themselves. Thus the capacity on the London-Paris circuit proved to be only one-half of that obtained by calculation, and every long circuit will require its own K to be determined by comparison with an empirical K R scale. Such a scale I have determined by careful experiment on artificial cables.

I have recently devised a new form of cable which will probably quadruple the rate of telegraph working to America; and I may say with all confidence that there is no theoretical reason whatever why we should not converse between London and every capital in Europe, while it is not impossible to speak even across the Atlantic.

VI.—Domestic Applications.

The era of the application of electricity to domestic purposes may practically be said to date from about the year 1850, when Hipp, of Neufchatel, introduced into the Berne Chamber of Deputies a system of electric bells.

There can be but little doubt but that the success which electric bells for domestic purposes has attained has been mainly due to the introduction, in 1866, of the Leclanché battery.

The success of fire and burglar alarms, as applied to houses and worked by electric action, has been very partial, and chiefly, no doubt, because these appliances, being very seldom required for use, get out of repair, and have an unfortunate trick of failing exactly at the time when they are most required.

Electric clocks have been a very favourite subject for invention, but the record, with a few marked exceptions, is practically one of failure, representing much ingenuity but little real utility.

Electric hoists, devised by Siemens, Hopkinson, Crompton, and others, have been used to some small extent; but their introduction has not been so extensive as might have been anticipated. One cause of this is, no doubt, the want of a good self-starting alternate-current motor; but it is more especially due to the question whether, at present high prices, electric energy for the purpose can financially compete with the generally adopted means of working the hoists.

For ventilation purposes on a small scale, the adoption of electric fans should prove of considerable value, as such fans can be placed in any convenient place out of sight and be contained in a very small compass.

I must not omit to mention the large use of "electric gas-lighters," an invention which has hardly received the full credit which it deserves.

VII.—Electro-chemical Industry.

There are few oxidising and reducing processes in chemical industry which cannot be effected economically and with advantage by the electric current, and the extreme cheapness with which electrical energy can be manufactured when used continuously, and when produced by falling water, as well as the extreme purity of the resulting deposits, are calling earnest attention to this lucrative branch of the business. It is not impossible to produce a kilowatt-hour of electrical energy by means of water power for 0·1d., and when this is stated to be equivalent to gas used for illuminating purposes at 0·6d. per 1,000 cubic feet, it will be seen what a potentiality of wealth there is in this (at present) much-neglected waste energy of Nature.

VIII.—Electric Lighting.

The development of the electric light has been seriously retarded in England by the operations of a monster called into existence by the limited liability legislation of recent years—the rapacious financial promoter—whose plunder in one year of our period far exceeds in

amount the sum of all the thefts of all the highwaymen and burglars that were ever hung. He has ruined the prospects of private enterprise, and has rendered absolutely necessary the Acts of 1882—88, which have thrown the industry into the hands of the local authorities of our cities and boroughs.

The glow lamp has been greatly improved, and as this year will witness the expiry of the controlling master patent, we shall see the price reduced to something not far from 1s.

The cost of wiring is a deterrent to the introduction of electric light into small tenements and into houses held on short tenures. The materials used must be of the most perfect kind, otherwise insecurity is incurred; but there are expensive practices of wood casing and of ornamentation which want reform. The "cheap jack" is the curse of the industry, and the absence of specification and of inspection the danger of the user. The fire insurance offices have maintained our practice in England pretty secure, but in other countries the character of the worker has been very indifferent. The prejudice against high pressure is still strong, but time and experience will eradicate it as they ultimately eradicate every fallacy.

The progress in electric lighting is now principally economical. If a full load could be maintained during the whole 24 hours, electrical energy could be manufactured for one-third of a penny per supply unit, and this is equivalent to gas at 2d. per 1,000 cubic feet.

The rate of growth of the industry is shown by the following returns:—

London.

Dec., 31st, 1890	145,000	electric lamps fixed.
„ 1891	330,000	„ „
„ 1892	500,000	„ „

	Bradford. (Lamps.)	St. Pancras. (Lamps.)	Brighton. (Lamps.)
1889	1,000	—	—
1890	8,467	—	—
1891	15,000	13,000	2,572
1892	20,000	21,000	10,248

Many efforts are being made to utilise the waste forces of Nature in producing electric currents for the economical supply of the light. In America, Scotland, Switzerland, Italy, and, indeed, wherever waterfalls are available, electric plant is being installed to convert the energy of the fall into the useful form of electricity.

Water power abolishes the coal bill, but it must be remembered that the cost of maintenance of machinery and of the erection and unkeep of conductors limits the distance to which the energy of falling water can be economically transmitted. The proposal to light New York by currents generated at Niagara is at present financially absurd. It is doubtful whether it will be commercially advantageous at Buffalo, 30 miles away.

There is much water power in this country that might be usefully employed. At Worcester it is proposed to use the water of the Teme, a tributary of the Severn, to supply electrical energy to the city—an experiment that will be watched with considerable interest, for the use of water power will solve the difficulty occasioned by light loads during the small hours and daylight.

IX.—POWER TRANSMISSION.

The oldest proposal for transmitting power electrically over a distance is probably that contained in the patent specifications of H. Pinkus, who proposed in 1840 to work an electric railway by power obtained from large primary batteries established on the line, but not carried on the trains. Pinkus must have contemplated transmission of current by wire. The first time power transmission was publicly shown was by Fontaine in the summer of 1873 at the Vienna Exhibition; but whether the discovery of the reversibility of the dynamo and of the possibility of transmitting energy from a generator to a motor through a long length of cable was purely an accident or the outcome of conscious investigations is not known. The first electric tramway was that shown by Siemens in 1881 at the Electrical Exhibition in Paris.

Since then the industry has begun to develop, and many electrical engineering firms took up power transmission. In 1882 Mr. Gisbert Kapp discovered that it was possible to get constant speed at the motor under extreme variations of load if the generator and motor were series machines and had characteristic curves which corresponded to each other. In 1886 Mr. Mordey pointed out that a shunt motor regulates for constant speed under varying load if the supply voltage is kept constant. France has very much developed this industry; in Italy we have magnificent examples in Genoa and Tivoli; but it is in Switzerland, where water power is so abundant, that it has flourished so well.

Ferraris and Tesla in 1888 discovered, independently, the rotary field motor worked by multiphase alternating currents. With this discovery the range of transmission has been enormously extended, since much higher voltages than are possible with continuous currents can be employed. Meanwhile, power transmission by single-phase alternating current has also been developed, the earliest example of magnitude being the electric lighting station at Cassel, designed by Oscar von Miller, and started in the beginning of 1891. The Heilbronn three-phase transmission, started a year ago, is working most satisfactorily for distribution of light and power. Inventors are, however, busy on single-phase alternating current motors, so that existing alternating current stations may distribute power as well as light, and Messrs. Ganz & Co., Messrs. Brown and Boveri, and the Œrlikon Works have already produced serviceable motors working by single-phase current.

X.—ELECTRIC TRACTION.

The use of electrical energy for working railways is making gigantic progress in the United States, and has commenced to make a serious move in the United Kingdom. The City and South London Electric Railway has proved a decided success, and next week will record the opening of a still larger enterprise on the elevated railway of the Mersey Docks in Liverpool. When last I visited America, in 1884, there was only one electric railway in work, and that was in Cleveland. One company alone, the General Electric Company of the United States, working the Thomson-Houston and Edison systems, has now—

Roads in operation and under contract ...	440
Cars	8,856
Miles of line in operation	4,628

Thus the average length of electric railway is 10·5 miles, and the average number of motor cars in use about two per mile. The power used is over 100,000 H.P. Speeds of 40 miles an hour are sometimes obtained in the open country, but in the crowded streets this rate is much reduced.

In 1892 there were 250,000,000 passengers carried, 50,000,000 car miles run. The capital invested in such railways is £12,000,000, and the cost of working comes out at 6d. per car mile. All these railways are worked with overhead conductors, by what are known as trolley lines. Such a line is at work in Leeds, and the South Staffordshire Tramways have just started the same practice.

Considerable experiments have been made to work tramcars by accumulators carried on the car. They have not met with much success, owing to the cost of renewals. The Birmingham Central Tramways are, however, persevering in this direction, and they are now giving an extensive trial to a new form of accumulator—the Epstein—the proprietors of which have adopted the novel plan of undertaking to renew the accumulators at the rate of 1½d. per car mile.

XI.—THEORY.

For many years past I have never regarded electricity as anything else but as a form of energy, and its effects as modes of motion of the molecules of matter and of the ether that fills all space; and during my long apprenticeship of 40 years I have never examined one experiment or considered one fact that was not explicable on this theory.

It must be distinctly understood that I apply the term *electricity* to that form of energy which we as engineers utilise in the service of man. I do not apply it, as some physicists do, to a mere imaginary factor of this energy, sometimes called "quantity," and even honoured with a unit—the *coulomb*. I use it in the same sense that we use the terms *light*, *heat* and *sound*, which are universally acknowledged to be forms of energy. In my address as President of the Mechanical Section of the British Association at Bath in 1888, I pointed out the great confusion that arose from this misapplication of terms, and I suggested that the disturbing factor—the vague subjective unreality of the physicist—might be called by some other term. I now go further, and suggest that the term be abolished altogether. We can do without it. It is not wanted. We have excluded the coulomb from our new legal system of C.G.S. units.

Electricity is energy which is transmitted by matter and through space by certain disturbances, the result and the equivalent of work done, and in certain orderly and law-regulated forms, called "electro-magnetic waves." One kind of wave gives us light, another radiant heat, another magnetism, and another electrification. The rate at which these waves move is the same, viz., 30,000,000,000 centimetres, or 192,000 miles per second. It is only their form and their frequency that differ. The rate of their propagation is the same in ether, air, and conducting wires.

The most recent discoveries and deductions are all in accordance with this mechanical theory. J. J. Thomson's views that at high temperatures, in the act of dissociation, all gases, and Dewar and Fleming's conclusion that at low temperatures—in fact, at the absolute zero of temperature—all metals become perfect conductors, might almost have been predicted. Hysteresis and Foucault losses are mere wastes of energy, due to molecular friction or to internal work done on the molecules, assisted by bad design and impure material; but, being measurable and comprehensible, their reduction to a minimum has become possible and actual.

It is a misfortune that a beautiful hypothesis like Maxwell's electro-magnetic theory of light has been discussed almost solely by mathematicians. Its consideration has been confined to a small and exclusive class. It has not reached the public; and this is to be regretted, for, after all, it is the many, and not the few, that determine the acceptance or refusal of a theory. The existence of the ether is now thoroughly comprehensible. Light is now regarded as an electro-magnetic disturbance. The eye is an extremely sensitive and delicate electro-magnetic instrument. The difference between luminous, thermic, and electro-magnetic waves is one of frequency and form. We thus have to consider the propagation of these waves not only in the conductor and in the dielectric in the direction of the circuit itself, but in the ether at right angles to this direction. The former produces currents in the conductor, and the latter induction and secondary effects in contiguous conductors. Thus it is easy to see why electric and magnetic lines of force are at right angles to each other, and each of them perpendicular to the line of propagation of the primary electro-magnetic wave, and why the transversal disturbances are secondary waves of electro-magnetic energy which can be transformed into electric currents of opposite direction whenever contiguous conductors lie in their path so as to be cut by these lines of force in the proper direction. Induction is thus mere transformation of energy whose direction and magnitude are easily calculated.

It is by following out this line of thought that I have recently succeeded in sending messages by Morse signals across the Bristol Channel between Lavernock and Flat Holm, a distance of 3·1 miles. The electro-magnetic disturbances were excited by primary alternating currents in a copper wire, 1,237 yards long, erected on poles

along the top of the cliff on the mainland. The radiant electro-magnetic energy was transformed into currents again in a secondary circuit, 610 yards long, laid along the island. The strength of these secondary induced currents complied almost exactly with calculations. The results attained, the apparatus used, the precautions taken to separate effects of induction from effects of conduction; the elimination of mere earth currents from electro-magnetic disturbances in air, will form the subject of a separate paper, for their proper consideration would be too tedious for an address. I allude to them now only to illustrate the existence of one of the greatest proofs of the truth of a theory, viz., the practical development and verification of a conclusion predicted from mere theoretical considerations.

The advance of our knowledge has been very much retarded by the phantasies of visionary mathematicians who monopolise the columns of our technical literature and fill the mind of the student with false conclusions. I have no sympathy with the pure mathematician who scorns the practical man, scoffs at his experience, directs the universe from his couch, and invents laws to suit his fads. The American, in his quaint, humorous way, said, "Theory without practice is absolutely a worthless commodity; practice without theory is worth about $15 a week; but when both are well combined in one man of sound judgment, the combination is worth up to $10,000 a year."

ELECTRIC BALLOON SIGNALLING.

A PAPER on "Electric Balloon Signalling" was read on Friday last by Mr. Eric Stuart Bruce before the Royal United Service Institution. The author pointed out that to obtain altitude as a means of signalling had for some time past been the aim of both the naval and military engineer. It had been suggested that the fleeting clouds might be used as a medium to reflect an intermittent beam of light upon them from the ground, but a cloud might vanish in delivering a message, in the midst of a word, the result being disastrous mistakes and confusion. Rocket signalling, though useful for a preconcerted signal, could not be said to be well adapted for conversation by sea or land. A great step in advance was made when the value of the captive balloon became recognised as a means of obtaining altitude for signalling in the field, and which could be carried on from the car of the balloon by flags, lanterns, and other methods. But signalling from the car of a balloon necessitated the use of a balloon of considerable size, for it must not only be able to lift itself and the captive rope, but also the car and one or more signallers. Then the transport of an ordinary balloon equipment was an important matter, necessitating a considerable number of steel tubes of compressed hydrogen gas, or a bulky apparatus for generating the hydrogen on the spot. Mr. Bruce remarked that notwithstanding the past difficulties which had beset aerial signalling, he thought they would all agree that no army could be termed to be properly equipped that did not possess some such practical method, nor was there a navy that would not be better armed by the addition of a ready means of signalling at altitudes.

The author observed that a few years ago the idea occurred to him to so apply electric flash signalling to a captive balloon that the operator and most of the apparatus might remain on the ground. In this system, as the weight of the car and operator is abolished, the balloon can be of such a size to be portable, quickly inflated, and easily manipulated. The apparatus is as follows: In the interior of a balloon, which is made of translucent material, and filled with pure hydrogen or coal gas, are placed several incandescent lamps. The lamps are in metallic circuit with a source of electricity on the ground, and in the circuit on the ground is an apparatus for making and breaking contact rapidly. By varying the duration of the flashes of light in the balloon it is possible to signal according to the Morse or any other code. In his experiments, the author had used four different sizes of balloons; the largest had a gas capacity of 4,200 cubic feet, and a diameter of 20 feet; and the smallest of 1,600 cubic feet, and was 14 feet in diameter. The former was considered to be the most satisfactory for military purposes, and with pure hydrogen such a balloon would lift over 1,000 feet of electric cable, whilst the smaller sizes were more suitable for navy signalling. The material used for making the balloons was thin cambric, and this, when coated with a varnish of a light colour, formed an exceedingly translucent medium. It being impossible to inflate in that theatre a balloon of the size required for practical use, the author showed a working model with the actual apparatus employed for making and breaking contact. In outward form it resembled a Morse key, but in reality it was essentially different, as an ordinary Morse key would not be able to withstand the current used to light the lamps. The first key he had used had a rubbing contact faced with platinum, and was the form of key supplied to the British Government. He had, however, discarded that and adopted an improved key having carbon contacts, which were easily renewable at trifling cost when worn away by sparking. That type of key had been introduced by the Belgian Government. The key was placed on a switchboard, so that the current could be turned on to the lamps in the balloon, either through the key or directly for continuous illumination. Before describing the other parts of the apparatus, Mr. Bruce showed the model balloon in operation, the sentence signalled being "Bridge repaired."

The speed of signalling depended upon the thickness of the carbon filaments in the lamps arranged in the balloon, and by the use of very thin filaments it was possible to attain considerable speed. The arrangement for suspending the lamps inside the balloon consisted of a holder made like a ladder, so that the lamps were placed one above the other in multiple arc. Six lamps of nominally 8 C.P., but worked to a much higher candle-power, yielded good results. The signals produced by six such lamps were seen at Uxbridge, a distance of 16 miles, when the balloon was on exhibition at the Albert Palace, Battersea. By increasing the candle-power, the distance the signals could be seen was naturally augmented. When the author first commenced his experiments he was assured by an eminent electrical engineer that continuous flashing would so shorten the life of the incandescent lamps as to render the method almost impracticable. Experience had, however, shown that such was not the case, although the lamps in his balloons had been systematically worked to almost double their candle-power. In the valve of the balloon was a pulley block by means of which the ladder of lamps was hauled up into the balloon and its height adjusted after the baloon had been filled with gas.

The electric cable which connects the lamps to the signalling apparatus on the ground, is made of strands of copper, and the captive rope and cable could form one cable. There was however an advantage in keeping the two separate: In the case of wind, the cable, hanging loosely, acted as a guy rope to steady the balloon. The first cable made weighed about 40 lbs. per 500 feet of twin cable, but an improved type of the same current capacity and flexibility weighed only 30 lbs. for the same length. As a source of electric power, the author had generally used storage batteries, and when a dynamo was available for recharging, that was the best method. The battery used comprised 25 cells weighing about 5½ cwts. and occupying a space of 3 feet by 1 foot 8 inches. Under circumstances where a dynamo might not be at hand, a small steam engine and dynamo combined would be the best method, or a gas engine operated by the hydrogen gas might be used. As far as the gas necessary for inflating the balloon was concerned, the most convenient arrangement was to use hydrogen gas compressed in cylinders, and it was preferable to use pure hydrogen to carburetted hydrogen, as the former had about double the lifting power of the latter. Mr. Bruce believed that the British Government was the first to use gas compressed in cylinders for filling their balloons, and on the occasion of the official trial of his signalling balloon at Chatham, it was filled with hydrogen that had been used for balloon inflation at Suakim during the Egyptian war and re-bottled. He then showed by means of a small balloon how easily the filling could be accomplished.

An interesting fact was the arrangement of the lamps inside instead of outside or below the balloon. Whilst the candle-power was somewhat diminished by the method first mentioned, the best results were obtained by placing the lamps inside. The fact that in flashing incandescent lamps the filaments did not instantaneously cease to glow was apt to cause a blurring of the signals when naked lights were used, whilst, by placing them inside the balloon, that indistinctness was obviated, as the filament itself was never seen. This was illustrated by the throwing upon a screen of the image of the white hot filament of carbon inside a glow lamp, by connecting the lamp to the signalling key and by flashing the lamp. It was then seen that the glow passed away gradually.

Many persons even at present seemed to have an idea that the showing of a light in a balloon was a dangerous proceeding. In order to demonstrate the fallacy of this opinion the author had arranged a few experiments; hydrogen gas taking fire under certain conditions, but being incapable of itself supporting combustion. It might seem surprising, but it was, he said, true that a red hot poker could be placed in the body of gas in a balloon without setting fire to it. To illustrate this he showed a glass globe through which a continuous stream of coal gas was passing and the gas jets from which were ignited. The terminals of a battery, across which was stretched a piece of platinum wire, were arranged inside the globe. An electric current was next passed through the piece of wire until it became red hot, and the condition then was a piece of red hot metal unprotected inside a globe filled with gas. The same state of affairs said Mr. Bruce, and under similar conditions on a larger scale, would obtain with a balloon. Another interesting experiment was the showing that a naked electric spark occurring in the midst of the gas was harmless. It was pointed out how extremely valuable an electric balloon would be both for military and naval purposes, and that the object of such a balloon could be accomplished before it would be possible to hit it with bullets. Reference was then made to recent experiments with the balloon, and the author concluded by giving an historical account of the invention.

NEW PATENTS—1893.

933. "Improvements in electrical arc lamps." W. H. LAUDER. Dated January 16th.

1,005. "An improved method of electrically controlling railway signal and point levers." C. M. ANDERSON. Dated January 17th.

1,035. "Improvements in electrical indicating apparatus, chiefly designed for indicating the position of a ship's rudder." M. L. BOSSIERE, widow of Henri Bossiére, and P. P. BARBEY. Dated January 17th.

1,037. "Improvements in search light projectors and in other light giving and projecting apparatus, and more efficient distribution of the light produced, and in mellowing of the light rays." J. W. GRAYDON. Dated January 17th.

1,057. "Improvements in and relating to electric railways." H. H. LAKE. (Communicated by T. Harris, United States.) Dated January 17th.

1,077. "Improvements in electric telephone switch apparatus." W. P. THOMPSON. (Communicated by C. C. E. Lesenberg, Germany.) Dated January 17th. (*Complete.*)

1,098. "Railway junction electric signalling." W. E. LANGDON. Dated January 18th.

1,104. "The signalman's electric safety protecting stop catch." A. FENNEY and C. ECCLES. Dated January 18th.

1,112. "Improvements in charging primary batteries for electric lighting and other purposes." S. MILLER and C. J. GRIST. Dated January 18th.

1,166. "Improvements in electric switching devices." H. R. WOOD. Dated January 19th.

1,168. "Improvements in the production of sodium carbonate and sodium bi-carbonate from metallic sodium or metallic sodium vapour, the said sodium or sodium vapour being obtained electrolytically, or by other methods." J. B. PETRIE. Dated January 19th.

1,198. "Improvements in multiple carbon arc electric lamps." J. BROCKIE. Dated January 19th.

1,219. "Improvements in single phase alternate current motors." C. E. L. BROWN. Dated January 19th.

1,229. "Improvements in secondary or storage batteries." H. H. LLOYD. Dated January 19th. (*Complete.*)

1,261. "Improvements in dynamo-electric machines." E. CONRADY and E. CONRADY. Dated January 20th.

1,309. "Improvements in or relating to dynamo-electric machines." H. COURTEEN. Dated January 21st.

1,336. "An automatic switch for obtaining continuous electrical current from a series of open circuit batteries." E. BLAMIRE. Dated January 21st.

1,343. "Improvements in interlocking apparatus for railway signalling." S. T. DUTTON. Dated January 21st. (*Complete.*)

1,344. "Improvements in interlocking levers in railway point and signal apparatus." W. G. SCOTT. Dated January 21st. (*Complete.*)

1,354. "Electro-thermal conductors, plates, tubes, and the like." Sir C. S. FORBES, Bart. Dated January 21st.

1,355. "Improved apparatus for forming electro-thermal plates, tubes, conductors, and the like." Sir C. S. FORBES, Bart. Dated January 21st.

1,356. "Improvements in electric gas lighting appliances and devices." A. M. SLOSS. Dated January 21st. (*Complete.*)

1,368. "An appliance for escape of gas from battery cells." H. C. GOVER. Dated January 21st.

1,382. "Improvements in phonoporic inductors." W. LANGDON-DAVIES and C. W. S. CRAWLEY. Dated January 21st.

1,387. "Apparatus to facilitate the placing of electric or other cables or wires within, and the removal from, pipes or conduits." E. T. MERCER and M. G. ROSS. Dated January 21st.

1,388. "Improvements connected with boots and shoes and galvanic chains or bands therewith, for curative purposes." N. MITCHELL. Dated January 21st.

1,391. "Improvements in electric arc lamps." K. SCHLEYDER. Dated January 21st.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

The Price of all Specifications (old and new) is now 8d. each.

8,961. "An improved method of and apparatus for measuring electric currents." A. CAMPBELL. Dated May 26th. The object of this invention is the measurement of electric currents, and thence differences of potential, by means of the expansion of a fluid partially contained in a thin-walled hollow conductor, part of which conductor is heated by the passage of the electric current. 8 claims.

9,107. "A connecting union for electric light fittings and the like." G. H. BARNES. Dated May 29th. Consists of two pummells and a cap, the first pummell has a hole through centre, square at one end and screwed on the outside at same end, to take cap, the other end left to screw or solder to fittings as required. The second pummell has a projecting square to fit into square hole of first pummell, a hole through the centre, a shoulder or flange on the outside for the cap to bed against, the other end of this is also left to screw or solder as required to electric fittings. The cap is screwed inside, the internal projecting part is turned to fit against the flange of second pummell, the screwed part of cap fits on to the screwed part of first pummell and secures the two pummells together. 1 claim.

9,555. "Improvements in carbons or electrodes for arc or other electric lamps." J. E. A. GWYNNE. Dated June 5th. The essential feature of the invention consists primarily in forming an initial crater and corresponding cone upon the positive and negative electrodes of an arc electric lamp or other electric lamp of a similar kind, so that an arc of the proper shape, luminosity and focal position may be established directly the current of electricity is applied to said lamp without the uncertainty, waste of time, power and carbon or other material resulting from the use of electrodes as hitherto made and used. 2 claims.

10,425. "Improvements in or relating to means or apparatus for illuminating roundabouts and the like with electric light." F. W. DICKINSON. Dated June 19th. The inventor mounts the dynamo upon a suitable carriage on which may also be fixed a suitable engine for driving it; and which may be arranged to receive the steam from the same boiler that supplies the engine employed for working the roundabouts. In order to convey the electric current from the dynamo to the revolving top of the roundabout, he fixes to the carriage of the roundabout engine a suitable upright carrying one or more insulated conducting discs or brushes, which are made to come in contact with one or more insulated metal rings mounted on the frame work (at a suitable distance from the centre) of the revolving top. To the insulated rings the conductors leading to the electric lamps are attached. 5 claims.

10,548. "Improved apparatus for mechanically winding electrical wires." W. SHARROW. Dated June 20th. In order to hold the armature, field magnet, ring or the like in a position suitable for the purpose, the inventor employs a spider mounted upon a spindle and having a suitable number of adjustable radial arms, and device for locking the same. The bobbin or reel containing the insulated or other wire turns upon a spindle, fitted with adjustable friction device or tension regulator, and mounted in bearings upon the top flange of a hinged split bush which has on its underside a flanged driving pulley. The bush revolves in a split bearing or sleeve fitted with a locking device, which is hinged to a bracket conveniently arranged to suit the work. Immediately in front of the reel or bobbin is mounted a hollow feeding finger through which the wire passes, and near thereto is a reversible adjustable follower which keeps each turn of wire in place as it is laid on. 2 claims.

10,703. "Improvements in the manufacture of the arms or attachments of telegraph poles for carrying insulators." H. C. JOBSON. Dated June 23rd. Consists in making the arms or attachments of telegraph poles for carrying insulators of moulded and compressed paper pulp or indurated or wood fibre. 1 claim.

16,421. "A new or improved electric lighting system." J. M. ORMES. Dated October 26th. Consists first, in the combination, with a dynamo-electric machine or other source of constant electric supply and a series of electric circuits for the supply of lamps, of a switch and transformer located between such dynamo or other source of energy and the working circuits, and an electric magnet interposed between such switch and transformer and the lamps; second, in the peculiar construction of the switch and transformer, whereby it is self-ventilating and adapted not only to serve as a switch, but to also act as a secondary coil in connection with the electro-magnet; third, in the appliances used in preventing sparking and the development of heat at the break of current on the switch and transformer, and fourth, in various other constructions and combinations of part. 8 claims.

19,617. "Improved exciting fluid for galvanic zinc carbon batteries, and method of recovering useful products from the spent fluids of such batteries." M. MUTHEL. Dated November 12th. Relates to a novel chromic acid exciting fluid for galvanic batteries, characterised by the employment of bisulphate of ammonia, and which, in consequence of its composition, renders it possible to regain the chrome and the zinc from the spent fluid. 3 claims.

22,718. "Improvements in machines for heating metals by electricity, also applicable for use in combination with apparatus for making springs." G. D. BURTON and E. E. ANGELL. Dated December 29th. Relates especially to a machine for heating metallic bodies of any shape or size or heating determined points thereof by electricity, and it consists in certain novel features, the object being to produce a simple and effective device of this character. 22 claims.

22,720. "Improved methods of and apparatus for heating metal articles by electricity." E. E. ANGELL. Dated December 29th. The objects of this invention are to provide a method and apparatus, in which the advantages of the electric current as a heating agent for metals may be utilised economically, and an apparatus in which the mechanism may be adjusted with facility for the proper heating of any given tool of the class above indicated, and then utilised for the uniform heating to the same degree of temperature of any number of like tools. 18 claims.

1892.

4,157. "Improvements in shades for electric glow lamps." H. W. TAYLOR. Dated March 2nd. Consists essentially in the employment of ox-horn, which, by reason of its semi-translucency and variegation of colour and texture, displays, when illuminated by being placed in close proximity to an incandescent glow lamp, an almost endless variety of natural markings and colourings, which enhance the effect of its partial translucency. 1 claim.

4,586. "Improvements in magnetic separators for ore and similar material." C. T. THOMPSON and R. H. SANDERS. Dated March 8th. Consists in the following combination of devices:—A hollow rotating drum is provided with stationary exterior magnets whose poles envelop a portion of the exterior periphery thereof, the wall or shell of the drum being of such character, and the magnet of such energy, as to ensure the formation of a magnetic field throughout a portion of the interior of the drum. A stationary discharge chute is arranged within the drum beneath the upper limit of the magnetic field, and leads therefrom to a point exterior to the drum. The material to be treated is fed in at one end of the drum and caused to travel, preferably by gravity, towards the other end as the drum rotates. During such travel, those portions of the ore or other material which are susceptible to magnetic action are attracted outwards towards the magnetic poles and are thereby held against the inner surface of the drum, rising with it in rotation until they reach the upper limit of the magnetic field which overhangs the chute. As soon as that portion of the drum against which they have been held moves past said limit, they drop off from the inner surface of the shell into the chute and are removed, preferably by gravity, to any desired receptacles. 4 claims.